National Fenestration Rating Council

National Fenestration Rating Council Incorporated

NFRC 100: 2001
Procedure for Determining Fenestration Product U-factors

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Foreword

Consumers today have many energy saving fenestration product options to choose from. Advances in fenestration product technologies include the use of low-emissivity coatings, low-conductivity gas-fills, insulating spacers, and new frame materials and designs. While the use of one or more of these components will improve fenestration product thermal performance, it will also increase the complexity of the selection process.

This procedure has been developed by the National Fenestration Rating Council (NFRC) to meet the need for a uniform and accurate means for evaluating the U-factors of fenestration systems. This procedure uses state-of-the-art computer simulation software tools, with periodically updated optical properties, and physical hot-box testing. The U-factors established by this procedure are determined at a fixed set of environmental conditions. Consequently, the U-factors determined using this procedure may not be appropriate for directly determining seasonal energy performance.

This document combines and replaces NFRC 100 (1997) and NFRC 100-B (1999). The site built document, previously a separate document named NFRC 100-SB has been incorporated into this document as Part II, NFRC 100SB.

The procedure to evaluate total product solar heat gain coefficient, and visible transmittance is *NFRC 200*; to determine glazing layer optical properties is *NFRC 300;* to determine air leakage rates is *NFRC 400;* and to determine condensation resistance rating is *NFRC 500*.

Ratings per this procedure are based on computer simulations. A physical test on a representative specimen is used to validate product conformance and the computer simulations. Products that cannot be simulated shall use ratings based on physical testing.

This document is in SI units followed by I-P units in parentheses. SI units are primary. I-P units are conversions for reference only.

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1.0 General Section

This section applies to all fenestration products included in the scope of this procedure.

1.1 Purpose

To specify a method for determining fenestration product U-factor (thermal transmittance).

1.2 Scope

1.2.1. Fenestration Products Covered by NFRC 100

(a) Products of all types as defined in Table 1.
(b) Products of all frame materials including but not limited to aluminum, steel, thermally broken aluminum, wood, vinyl, reinforced vinyl, fiberglass, and plastic, used singularly or in combination, or products utilizing foam as a core material.
(c) Products of all glazing materials, tints, and types, such as but not limited to, clear glass, tinted glass, stained glass, glass block, thin plastic films (internally suspended, internally applied, or externally applied), rigid plastics, and translucent fiberglass with or without any solar control, low-E or any other partially transparent coating and products with manufactured decorative opaque insulative glazing panels, designed for interchangeability with other glazing options.
(d) Products with any or no gap width between glazing layers.
(e) Products with any spacer or spacer systems between glazings, such as but not limited to metallic, non-metallic, or composite spacers.
(f) Products utilizing any and all glazing dividers, such as but not limited to interior, exterior, or between glazing grilles, muntin bars, true divided lites, or simulated divided lites.
(g) Products with any gas-fill between glazing layers, such as, but not limited to air, argon, krypton, or mixes of these gases; and
(h) Products utilizing shading systems between glazing layers, currently limited to those that are an integral, i.e., non-removable, part of the product.

1.2.2 Fenestration Products and Effects Not Covered by NFRC 100

(a) Products with shading systems other than those listed in 1.2.1(h);
(b) Thermal performance changes of a fenestration product over the course of time, i.e., long-term energy performance; and
(c) Issues of water tightness, structural capacity, and air leakage.

1.3 Terminology

Areas

Center-of-glazing area (A_c): all glazing areas except those within 63.5 mm (2.5 in.) of any part of a primary sash and/or frame and/or divider; or any part of a primary door and/or frame and/or divider. See Figures 1, 2, 4, 5, 6, 7, 12 and 13.

Divider area (A_d): the projected area in the plane(s) parallel to the fenestration product's glazing of all interior or exterior applied non-removable dividers, true dividers, simulated dividers or between glazing dividers See Figures 1, 2, and 8.

Door core area (A_{dc}): the projected area of the door less the frame, edge of frame, lite glazing frame, edge-of-glazing, center-of-glazing, edge-of-divider, divider, edge-of-panel, and panel areas. See Figures 3, 4, 5 and 7.

Edge-of-divider area (A_{de}): all glazed vision areas within 63.5 mm (2.5 in.) of any part of a divider area. The edge-of-divider area shall exclude any edge-of-glazing area. See Figures 1, 2, 4, 5, 6, 7, 12 and 13.

Edge-of-glazing area (A_{eg}): all glazed vision areas within 63.5 mm (2.5 in.) of any part of the frame and sash, or of the door lite frame sight line, excluding any divider or edge of divider. See Figures 1, 2, 4, 5, 6, 7, 12 and 13.

Edge-of-panel area (A_{ep}): the projected area extending from the point 25 mm (1 in.) of uniform thickness on the panel, to the point which includes 25 mm (1 in.) of door core material from the interface of any decorative bead or from the interface of the panel cutout and the door core. See Figures 3, 4, 5 and 7.

End stile area (A_{es}): the projected area of the end stile in the plane(s) parallel to the garage door surface. See Figure 13.

Frame area (A_f): the projected area of frame and sash in the plane(s) parallel to the glazing surface, - except for doors, which shall include the projected areas of the door jambs, header, threshold, door bottom sweep and the peripheral structural elements of the door leaf, in a plane parallel to the door core surface. See Figures 1, 2, 4, 5, 6, and 7.

Lite frame area (A_{lf}): Specific to doors, the projected area extending from the sight line of the lite frame into the surrounding homogeneous door core surface for a distance of 25 mm (1 in.) beyond the outer edge of the lite frame, and parallel to the door core surface. See Figures 4, 5, 6, 7 and 8.

Panel area (A_p): the projected area of all decorative panels of uniform thickness and extending from a point 25 mm (1 in.) of uniform thickness, in a plane parallel to the door core surface. See Figures 4, 5, 6, 7, 11, 12 and 13.

Projected fenestration product area (A_{pf}): the area of the rough opening in the wall or roof, for the fenestration product, less installation clearances.

[Note: *Where a fenestration product has glazed surfaces facing in only one direction (typical products), the sum of the edge-of-divider area, the edge-of-glazing area, the divider area, the center-of-glazing area, and the frame area will equal the total projected fenestration product area (A_{pf}). Where a fenestration product has glazed surfaces in more than one direction (e.g., greenhouse/garden, bay/bow windows) the sum of the areas will exceed the projected fenestration product area.]*

Total fenestration product area (A): the area of the total fenestration product that includes all frame, divider, edge-of-glazing, edge-of-divider, and center-of-glazing areas.

Awning window: a window with one or more sash that rotate about its top hinge and projects outward.

Baseline product: within a product line the individual product selected for validation testing. To verify door glazing and lite frame simulations, the baseline product for door and sidelite product lines, which include glazed options, shall include glazing.

Base profile: Primary structural member of a fenestration product line, which forms the basis for comparison such as groupings.

Basement window: a window usually with one sash that projects inward, and intended to be used at or below grade. Rated as the appropriate product type.

Bay window: a combination assembly which is composed of two or more individual windows joined side by side and which projects away from the wall on which it is installed. Center windows, if used are parallel to the wall on which the bay is installed. The two side windows are angled with respect to the center window(s). Common angles are 30° and 45°, although other angles are sometime employed. Individual windows are rated as the appropriate product type.

Bow window: a rounded bay window that projects from a wall in the shape of an arc. Individual windows rated as the appropriate product type.

Caming: material that divides and holds pieces of glazing together to form a single decorative glazing panel.

Casement window: a window containing one or more sash hinged to open from the side, that project outward or inward from the plane of the window in a vertical plane. A conventional casement window has a sash that projects outward.

Cladding: An applied rigid or semi-rigid roll-formed or extruded covering that is placed over, or attached to, and follows the contour of the interior or exterior framing member for the primary purpose of protection from environmental elements and/or aesthetics, and adds no structural integrity to the framing member.

Combination assembly: a window, door or skylight assembly formed by a combination of two or more separate units whose frames are mulled together.

Composite unit: a window, door or skylight unit consisting of two or more sash or product types within a single frame utilizing an integral mullion. If a composite unit is made of different product types each product type shall be rated separately. Composite units of fixed beside sliding or side-hinged and fixed over/under sliding or top/bottom hinged shall be rated per Table 1. Other composite unit configurations incorporating fixed sash shall be rated per the Table 1 configurations.

Decorative panel/Panel insert: a decorative raised molding that is inserted into a cut-out in an insulated door slab. Decorative panels are typically molded from a composite material. The gap between the two halves of the panel may be filled with an insulating material.

Default frame components for door slab testing: See reference 2 for drawings.

(a) 115.00 mm (4.56 in.) softwood single rabbetted frame of 8 to 12% moisture content, with a specific gravity of 0.35 to 0.45, with a dual durometer plastic compression weatherstrip and flexible sweep. The default door sill shall be a standard combination wood/aluminum sill where the aluminum does not extend to the interior that performs as well or better than the default door sill illustrated in Figure 16-1 and 16-2.

(b) Steel default frame shall consist of a 145.00 mm (5.75 in.) - 16 Ga. pressed painted steel frame with a minimum 120.00 mm (4.75 in.) throat depth, applied weather-strip, and an aluminum non-thermally broken sill with a sill wall thickness of 1.400 mm (0.055 in.) to 1.600 mm (0.065 in) and no substrate. Frame shall consist of a head jamb, hinge jamb, lock jamb, and necessary anchors and reinforcement for hinges and locks. See Figures 10-1 and 10-2.

(c) Polypropylene door lite frame (See Reference 2) for composite.

(d) Default caming profile (See Reference 2)

Divider: any vertical or horizontal bar used to separate glazing into multiple lites, or placed in the gap between sheets of glazing. Dividers may be external or internal, may be removable or non-removable, and may be real or simulated. Dividers may also be called grids, grilles or muntins.

Door leaf: the pivoted or swinging portion of a door system. Sometimes referred to as a door slab.

(a) ***Composite (material) door:*** a door manufactured from skins molded from plastics, fiberglass compounds, compressed composites or other non-metallic materials. The door leaf may or may not incorporate a structural perimeter constructed from materials including, but not limited to wood, wood products, composites, or other reinforcing materials. The core of the door leaf may be filled with materials including, but not limited to insulating polyurethanes, styrenes, or honeycombs.

(b) ***Steel door:*** a door manufactured from steel skins, which may be coated with paint, plastic, wood veneers or other finishes. The door leaf may or may not incorporate a structural perimeter including, but not limited to materials of wood, wood products, composites, or other reinforcing materials. The core of the door leaf may be hollow or filled with material, including but not limited to insulating polyurethane's, styrene's or honeycombs.

(c) ***Wood door:*** a door manufactured from solid wood, wood veneers, wood laminates or a combination thereof. Such doors are generally assembled from stiles, rails and panels, but may also be wood flush doors of solid or hollow core construction.

Door/slab/slab door/fixed panel: a side hinged attachment, greater than 600 mm (24 in.) in width, whose primary function is to allow human egress, or non-operable panels greater than 700 mm (27 in.) in width.

Dual action window: a window that consists of a sash that tilts from the top, and

swings inward from the side.

Embossed/Raised panel: decorative areas on a door leaf. On a steel door these may be pressed into the steel skin or achieved by the application of plastics or other trim materials. On composite (material) doors these are usually molded into the door skin or may also be achieved by the use of surface applied trim. Wood doors usually incorporate thinner wood sections assembled into the stiles and rails. Note: See Figure 9 for Typical 6-panel layout.

Exterior door system: the total door system that includes all frame, lite frame, divider, edge-of-divider, edge-of-glazing, center-of-glazing, door core, edge-of-panel, and panel areas. The door, slab, or slab door together with the surrounding frame, weatherstrip, sill, and sweep.

Fixed window: a window designed to be non-operable.

Frame (door): the structural members into which the door leaf is installed, including the hinge jamb, latch jamb, head jamb, sill (threshold), door bottom sweep, and perimeter weatherstrip.

Frame and sash*:* any structural member of the fenestration product, with the exception of muntins or other dividers used to create true or artificial divided lites.

Glass: An elastic transparent material composed of silica (sand), soda (sodium carbonate), and lime (calcium carbonate) with small quantities of alumina, boric, or magnesia oxides.

Glazing/Glazing in-fill: A generic term used to describe an infill material such as glass, plastic or other transparent or translucent material used to enclose openings in a building created by a specific framing system. Opaque in-fill panels are allowed to be substituted for glazing in any of the calculations in this document.

Glazing system: the assembly of the glazing, spacer and dessicant combined to be placed in the opening in a window, skylight, door or sidelite.

Greenhouse/Garden window: a window unit that consists of a three-dimensional, five-sided structure. Operating sash are allowed but not required. Typically rated as a unit.

Grouping: two or more products within a product line represented by the worst performing product.

Horizontal sliding window: a window that contains one or more manually operated sash that slide horizontally within a common frame. Operating sash (X) and a fixed lite (O) comprising a unit is termed a single slider (XO) or (OX). When two operating sash are separated by a fixed lite, the unit is termed a picture slide (XOX), or end vent. When an operating sash separates two fixed lites, the unit is termed a center slide (OXO). When two bi-parting sash are located at the center of the unit with the fixed lites at each end, the unit is termed a bi-part center slide (OXXO). When adjacent sash by-pass one another, the unit is termed a double slide (XX or XXO) or a double slide and vent (XXX).

Individual product: within a defined product line, any one specific product, of any

size. See Section 1.4.2 for further details.

Lite: another term for a pane of glass. In this procedure used primarily with entry doors.

Model size: The size listed in Table 1 that is used to rate a fenestration product.

Mullion*:* a horizontal or vertical structural member connecting two or more products. Mullions may be of the following types:

Integral mullion – a member that is bounded at both ends by crossing frame members.

Combination mullion – a member formed by joining two or more individual fenestration products together without a mullion stiffener.

Reinforcing mullion – a member with an added continuous mullion stiffener and joining two or more individual fenestration products along the sides of the mullion stiffener.

Mullion stiffener – an additional reinforcing member used in a reinforcing mullion. Mullion stiffeners may be designed to carry the total load or may share the load with the adjacent framing members.

Obscure Glass: glass having an image, pattern or texture that distorts the vision through the glass.

Outdoor air ventilator assembly (OAVA): a device, other than a sash unit, for the purpose of controlling the passage of air though a fenestration product.

Product line: a series of individual products of the same product type as defined in Table 1. See Section 1.4.1 for further details.

Product type: designation used to distinguish between fenestration products base on fixed and operable sash and frame members. Note: referred to as *Operator Type* in previous versions of NFRC 100.

Roof window: a window designed for sloped application that provides for in-reach operation or sash rotation to facilitate cleaning the exterior surfaces from the interior of the building.

Representative size: The actual size of a product specimen that is used for validation testing.

Sash: the portion of a fenestration assembly that is installed in a frame and includes the glazing, stiles and rails. Sash may be operating or fixed.

Sidelite: a fenestration product that is used as a companion product installed on one or both sides of a door. Sidelites may consist of a glazed frame or a non-operable sash within a frame and shall not exceed 700 mm (27 in.) in width.

Sight line: the line formed by the inner profile of an opaque member (frame, sash or

divider) and the glazing in a plane perpendicular to the surface. (See Figure 19)

Sliding glass door: sliding glass doors contain one or more manually operated panels that slide horizontally within a common frame. Operating panel (X) and a fixed lite (O) comprising a unit is termed a single slider (XO) or (OX). When two operating panels are separated by a fixed lite, the unit is termed a picture slide (XOX), or end vent. When an operating panel separates two fixed lites, the unit is termed a center slide (OXO). When two bi-parting panels are located at the center of the unit with the fixed lites at each end, the unit is termed a bi-part center slide (OXXO). When adjacent panels by-pass one another, the unit is termed a double slide (XX or XXO) or a double slide and vent (XXX).

Sloped glazing: a multiple-lite glazed system (similar to a curtain wall) that is mounted at a slope greater than 15° from the vertical plane.

Sunroom/Solarium: a glazed envelope system that has one wall, or a portion thereof, that opens to a primary structure and remaining walls which may include a number of fenestration systems such as windows, doors, skylights, kneewalls, etc, in varying percentages per the design of the system.

Skylight: a sloped or horizontal application of a fenestration product in an out-of-reach application that allows for natural daylighting.

Thermal break: a material of low thermal conductivity that is inserted between members of high conductivity in order to reduce the heat transfer. Thermal barrier material conductivity shall not be more than 0.52 W/(m℃K) (3.60 Btu℃in/h•ft^2•F).

Thermally broken (TB) members: System members with a minimum of 5.30 mm (0.210 in.) separation provided by a low conductance material (where thermal conductivity ≤ 0.5 W/m*K, ≤ 3.6 Btu-in/h•ft^2•F) or open air space between the interior and exterior surfaces. Examples of such systems include pour and de-bridged urethane systems, crimped-in-place plastic isolator systems, and pressure glazed systems with intermittent fasteners.

Note 1: Intermittent fasteners shall be manufacturer's standard. Nominal spacing of fasteners shall be 150 mm (6 in.) apart or greater.

Thermally improved (TI) members: System members with a separation greater than or equal to 1.60 mm (0.062 in.) separation provided by a material (where thermal conductivity ≤ 0.5 W/m*K, ≤ 3.6 Btu-in/h•ft^2•F) or open air space between the interior and exterior surfaces. Such systems include members with exposed interior or exterior trim attached with clips and all skip/debridged systems.

Transom: a non-operable fenestration product that is used as a companion product installed above a door. Transoms may consist of glazed frame or a non-operable sash within a frame. For purposes of complying with this procedure transoms shall not exceed 700 mm (27 in.) in height. For operable fenestration products, see the appropriate product type.

Tubular daylighting device (a.k.a. TDD): a device primarily designed to transmit daylight from a roof surface to an interior ceiling surface via a tubular conduit. The device consists of an exterior glazed weathering surface, a light transmitting tube with a reflective inside surface, and an interior sealing device such as a translucent

ceiling panel.

U-factor, Overall Thermal Transmittance (a.k.a. U-value): a measure of the heat transfer characteristics of a fenestration product under specific environmental conditions. The U-factor multiplied by the interior-exterior temperature difference and by the projected fenestration product area yields the total heat transfer through the fenestration product due to conduction, convection, and infrared radiation. The U-factor is the heat transmission in a unit time through a unit area of a test specimen and its boundary air films, induced by a unit temperature difference between the environments on each side in W/(m^2•K) [Btu/h•ft^2•F)].

Center-of-glazing U-factor (U_c): the U-factor representative of the center-of-glazing area.

Divider U-factor (U_d): the U-factor representative of the divider area.

Door core U-factor (U_{dc}): the U-factor representative of the door core area.

Edge-of-divider U-factor (U_{de}): the U-factor representative of the edge-of-divider area.

Edge-of-glazing U-factor (U_e): the U-factor representative of the edge-of-glazing area.

Edge-of-panel U-factor (U_{ep}): the U-factor representative of the edge-of-panel area.

End stile U-factor (U_{es}): the U-factor representative of the garage door end stile area.

Frame U-factor (U_f): the U-factor representative of the frame and sash area.

Lite frame U-factor (U_{lf}): the U-factor representative of the lite frame area.

Panel U-factor (U_p): the U-factor representative of the panel area.

Total fenestration product U-factor (U_t): the U-factor representative of the total system.

Validation matrix: Two or more product lines whose U-factor can be validated by a single test.

Vehicular access door (garage door): a door that is used for vehicular traffic at entrances of buildings such as garages, loading docks, parking lots, factories, and industrial plants, that is not generally used for pedestrian traffic, which includes vertical jamb tracks, all divider, edge-of-divider, edge-of-glazing, center-of-glazing, door panel core, edge-of-panel, and stile (end cap) areas. Currently ratings in this procedure are for residential vehicular access doors only, ratings for commercial doors are under development.

Vertical sliding window: a window that contains at least one manually operated sash that slides vertically within a common frame. Operating sash (X) and a fixed

sash (O) comprising a unit are called single hung windows, and units with two operating sash (X/X) are called double hung windows.

1.4 Product Lines and Individual Products

U-factors shall be determined for all individual products within a product line.

1.4.1 Product Lines

A product line is a series of fenestration products of the same product type (as listed in Table 1) manufactured from the same profiles and differ only in:

(a) Size.
(b) Center-of-glazing and edge-of-glazing characteristics such as glazing types, glazing coatings, gas-fills, gap widths, use of dividers, use of spacers.
(c) Opening/non opening configurations, e.g., XO vs. XOX*.
(d) Changes to accommodate smaller/larger glazing unit thicknesses.
(e) Frame modifications made to accommodate operating hardware and reinforcement for the purpose of addressing higher/lower loads and stresses.
(f) Frame or sash changes where one component is replaced by another component of the same physical shape with a thermal conductivity that does not differ by more than 10 times the thermal conductivity of the original material.
(g) Interior/exterior appendages added to the main web of the frame that is not exposed after product installation, i.e., nailing fins.
(h) Clad products and unclad products can be incorporated into one product line. The clad and unclad products shall be separate individual products within the product line.
(i) Changes to the frame profiles to allow for different installations.
(j) Products manufactured in both in-swing and out-swing options.

The following changes shall be simulated, and shall be individual products within a product line:

(1) Changes to accommodate installation of an Outside Air Ventilator Assembly (OAVA), if required as defined in Section 1.4.2.
(2) Any sight line changes due to lengthening or shortening existing walls.

Two or more product lines of the same product type (as listed in Table 1) may be validated by a single test provided they meet the following requirements. Typically the first product line is validated, and then minor revisions are made to the profiles for either structural or aesthetic purposes. The new product line shall be simulated but validation testing is not required if the effect of the minor changes does not affect the thermal characteristics (affects U-factor 0.06 W/(m^2℃K) (0.01 Btu/h•ft^2•F) or less).

If the following changes, when simulated with the lowest center-of-glazing option, result in an overall product U-factor change of +/- 0.06 W/(m^2K) (0.01 Btu/h•ft^2•F) or less, both product lines may be within a validation matrix. If the overall U-factor

* An "X" denotes an operating panel/sash. An "O" denotes a fixed or non-operating panel/sash. Combinations of X's and O's denote the appropriate combinations of operating and non-operating panels.

changes by more than 0.06 W/(m^2℃K) (0.01 Btu/h•ft^2•F) then the new product line shall be validated:

(1) Changes to shift the location of the glazing relative to the sash or frame (exterior to interior).

(2) Changes of geometry or material type to stops, beads, adhesives or gaskets designed to retain the glazing.

(3) Changes to geometry or location of lift or pull handles.

(4) Adding components to allow for equal site-line products (filler bar).

(5) Product lines fabricated with both pocket and sloped sill options.

(6) Any changes to the internal cavities as long as the outside profile geometry does not change.

(7) Vinyl caps attached to the interior.

(8) Application of cladding to an unclad product.

Material changes where the conductivity changes by more than a factor of 10 are not part of the same product line except for the addition of cladding materials applied to the same base profile.

Combination assemblies shall not be rated in combination. Each product type shall be rated separately. Composite units of fixed beside sliding or side-hinged and fixed over/under sliding or top/bottom hinged shall be rated per Table 1. Other composite unit configurations incorporating fixed sash shall be rated per the Table 1 configurations.

Non-rectangular fenestration products shall be rated as rectangular fenestration products per the standard size in Table 1. Develop a product line with the same frame cross sections as the non-rectangular fenestration product.

Multipurpose products incorporating nearly identical frame/sash base profiles may be within one validation matrix, provided that the differences between the base profiles are limited to minor changes to accommodate different operating hardware. The minor changes will allow for the movement or addition of specific elements (i.e. walls & cavities) to accommodate the different operating hardware. Any elements added to the profile to accommodate operating hardware shall be of the same material types used in the original profile. Note: This also allows the use of the hung window sash stiles as the bottom rail, deleting of the roller track of the horizontal slider, the addition of sash balance covers, or any other component changes that occur as a direct result of the hardware changes. The difference between the total product U-factors of the two product types when simulated with the glazing option with the lowest center-of-glazing U-Factor shall not exceed 0.06 W/(m^2℃K) (0.01 Btu/h•ft^2•F).

1.4.2 Individual Products General

An individual product is any one specific fenestration product, of any size, within a product line specific to:

(a) center-of-glazing and edge-of-glazing characteristics;

(b) minor frame differences (variations on the base profile--see Section 1.4.1);
(c) sealing characteristic variables and elements; and
(d) opening/non-opening configurations, e.g., XO vs. XOX.

Variations in frame or sash interior/exterior finish, paint, varnish, or stain shall not constitute different products provided that each of these variations does not change the surface emittance by more than 0.1 or overall thickness by more than 0.400 mm (0.016 in.).

Continuous hardware, reinforcing, or other frame component changes to the same base profile shall be considered different individual products within the same product line.

Reinforced products and products without reinforcement with the same base profile shall be considered different individual products within the same product line.

Products with different glazing divider patterns do not need to be treated as different individual products. The manufacturer may define a standard glazing divider pattern (which shall be a standard product offering) which uses glazing dividers 300 mm (12 in.) on-center or less. If no standard product offerings exist with glazing divider patterns 300 mm (12 in.) on-center or less, a glazing divider pattern with an on-center spacing closest to but not greater than 300 mm (12 in.) shall be used as the glazing divider pattern. (See Figure 3).

Fenestration products that include an outdoor air ventilator assembly (OAVA) shall be considered the same individual product if the OAVA area, expressed as a percentage of the model size area, is less than the value computed in Equation 1. Products with an area percentage larger than given in Equation 1 shall be separate individual products.

$$P_{OAVA} = \frac{\left(W_{OAVA} \cdot H_{OAVA}\right)}{\left(W_m \cdot H_m\right)} \cdot 100 \quad \text{[Equation 1]}$$

Where:

P_{OAVA} = percentage of OAVA rounded up to the nearest 0.5%
W_{OAVA} = width of glazing in mm (in.) (see Figure 20)
H_{OAVA} = a constant, 45.00 mm (1.75 in.)
W_m, H_m = width, height of model size in mm (in.)

OAVA's shall be defined as devices, other than a sash unit, for the purpose of controlling the passage of air through a fenestration product. An OAVA shall not allow outside air access to cavities within the cross-sectional boundaries of the sash, frame, or glazing. Any components that are added to the fenestration product to facilitate the installation of the OAVA shall be considered to be an integral part of the OAVA for the purpose of calculating the total area of the ventilator assembly (See Figure 20).

1.4.3 Baseline Products General

The baseline product shall be the individual product selected for validation testing (see Section 1.6.1.1). The individual product selected as the baseline product shall have a simulated U-factor within 0.60 W/(m^2℃K) (0.10 Btu/h•ft^2•F) or 20% of the lowest simulated U-factor. Size variations shall be limited to the representative size as defined in Section 1.5.4 for the product type. If more than one product type is being validated with a single test then the baseline product shall be selected from all the product lines.

1.4.4 Simplifications to a Product Line

This section presents rules that may be used to reduce the number of simulations of individual products, which represent a product line.

1.4.4.1. Grouping Hierarchy

To assure consistent ratings, groupings shall be done in the following order:

1. Center-of-glazing
2. Spacer
3. Divider
4. Frame

Any combination of two, three, or four groupings shall be done in the order established above. All grouping comparisons shall be base on 3 significant digits.

Center-of- glazing

Once all center-of-glazing options have been identified within a product line, the center-of-glazing U-factor shall be simulated for each option. These products may then be grouped with each group represented by the center-of-glazing group leader, which shall be the center-of-glazing option with the highest center-of-glazing U-factor.

For the purpose of determining U-factors, center-of-glazing groups shall consist only of variations in glazing thickness, gap width, gas fill and low-e coatings.

Individual products which differ from another (base) individual product in glazing tint and/or obscurity (including obscure glass, fritted glass or wired glass) only may be assumed to have the same U-factor as the base product unless this change is associated with a change in coating properties.

Also, individual products that contain the same basic glazing configuration may be grouped. For example, a glazing option that has two clear sheets used in the composition of the insulating glass unit shall not be grouped with an insulating glass combination that contains one clear sheet and one low-e sheet

(e=<0.50). The U-factor for the glazing options with variations in the surface emittance value, as defined above, may be grouped but shall be listed as separate Individual Products in the Product Line.

Any individual glazing option that applies the 3.00 mm (0.118") rule for grids and identifies that the individual product is being simulated for U-factor as with or without grids shall only be grouped, or be the center-of-glazing group leader, with products that meet the 3.00 mm (0.118 in.) ruling. Any individual glazing option that is simulated without grids, whether due to air gap restrictions or non-compliance to the 3.00 mm (0.118 in.) rule, cannot be grouped with an individual product that is identified as being simulated with or without grids.

For center-of-glazing groupings with the only variation being the gap width, special attention shall be taken regarding false dividers, grids or suspended grilles. If there is a minimum of 3.00 mm (0.118 in.) space between the glazing surface and the divider, on each side, the center-of-glazing may be modeled as though there were no divider, grid or grille. If the clearance is less than 3.00 mm (0.118 in.), the divider, grid or grille shall be modeled. There are six configurations that may be considered for grouping. When grouping, the worst case U-factor shall be used as the Group Leader. Configurations are:

1. Large gap width without grids.
2. Large gap width with grids with 3.00 mm (0.118 in.) or more clearance between the grid and each glazing surface.
3. Large gap width with grids with less than 3.00 mm (0.118 in.) clearance between the grid and each glazing surface.
4. Small gap width without grids.
5. Small gap width with grids with 3.00 mm (0.118 in.) or more clearance between the grid and each glazing surface.
6. Small gap width with grids with less than 3.00 mm (0.118 in.) clearance between the grid and each glazing surface.

	May be grouped with configuration(s):			
Configuration #	**1,2**	**3**	**4,5**	**6**
1,2	---	Yes	Yes	Yes
3	No	---	No	Yes
4,5	No	Yes	---	Yes
6	No	No	No	---

IG units manufactured with breather or capillary tubes designed to remain closed after manufacturing shall be simulated as having the same gas content. IG units manufactured with breather tubes intended to be opened at some point after manufacturing shall be simulated as air-filled IG units.

Only individual products that contain the same gas-type may be grouped. For example, a glazing option that has air only shall not be grouped with a glazing option that contains argon or krypton gas. Variable concentrations of the same gas-fill type may be grouped as a center-of-glazing grouping as long as the gas concentration, other than air, is more than 60% and doesn't vary by more than ± 10% from the group leader. Glazing options with different gas-fills shall be simulated as separate Individual Products in the Product Line.

For gas concentrations allowed in simulations, see Reference 2.

Nominal glass thickness may be used for determining U-factor, provided the emissivity of the glass is taken from the approved NFRC Spectral data file and the air gap dimension is maintained at the dimensions specified by the manufacturer. The nominal glass thickness to be used shall be as listed in the attached table. The values in the table below have been taken from the ASTM C1036-97 standard.

Nominal Glass Thickness	Glass Thickness Range	
	Minimum Glass Thickness	Maximum Glass Thickness
2.50 mm (0.09 inches)	2.16 mm (0.085 inches)	2.57 mm (0.101 inches)
3.00 mm (0.12 inches)	2.92 mm (0.115 inches)	3.40 mm (0.134 inches)
4.00 mm (0.16 inches)	3.78 mm (0.149 inches)	4.19 mm (0.165 inches)
5.00 mm (0.19 inches)	4.57 mm (0.180 inches)	5.05 mm (0.199 inches)
6.00 mm (0.23 inches)	5.56 mm (0.219 inches)	6.20 mm (0.244 inches)
8.00 mm (0.32 inches)	7.42 mm (0.292 inches)	8.43 mm (0.332 inches)
10.00 mm (0.39 inches)	9.02 mm (0.355 inches)	10.31 mm (0.406 inches)
12.0 mm (0.47 inches)	11.91 mm (0.469 inches)	13.49 mm (0.531 inches)

If this approach is used, the total fenestration product U-factor for the center-of-glazing group leader shall be used to represent the total fenestration product U-factors for all individual products within that center-of-glazing group.

Spacer

After all spacer options have been identified within a product line, the frame and edge-of-glazing heat loss shall be simulated for each option using a representative cross-section with the lowest center-of-glazing U-factor in the product line.

These products may then be grouped with each group represented by the spacer group leader, which shall be the option with the highest whole product heat loss. If this approach is used, the total fenestration product U-factor for the spacer group leader shall be used to represent the total fenestration product U-factors for all individual products within that group. For the purpose of determining U-factors, spacer groups shall consist only of variations in spacer assembly materials and shapes.

Divider

Products with removable or non-removable dividers applied to the room side and/or exterior side glazing surface may be assumed to have the same U-factors as identical products without such dividers.

Products with glazing dividers between lites of insulating glass may be assumed to have the same U-factors as identical products without such dividers, providing there is at least 3.00 mm (0.118 in.) air/gas space between the divider and both glass surfaces.

After all divider options have been identified within a product line, the frame and edge-of-glazing heat loss shall be simulated for each option with the lowest center-of-glazing U-factor in the product line. These products may then be grouped with each group represented by the divider group leader, which shall be the divider option with the highest frame and edge-of-glazing heat loss. If this approach is used, the total fenestration product U-factor for the divider group leader shall be used to represent the total fenestration product U-factors for all individual products within that divider group. For the purpose of determining U-factors, divider groups shall consist only of variations in divider materials and shapes.

Frame

Products with integral appendages that extend beyond the rough opening and are not exposed after installation may be assumed to have the same U-factors as identical products without such appendages provided that the boundary conditions on either the exterior or interior does not change.

If a nail flange is not removable, and is identified as such by the manufacturer, the product shall be simulated and tested with the nail flange covered with a nominal 1 x 4 fir trim as referenced in the NFRC Simulation Manual. If a nail flange is removable, the product shall be simulated and tested without the nail flange.

After all frame options have been identified within a product line, the frame and edge-of-glazing heat loss shall be simulated for each option with the lowest center-of-glazing U-factor in the product line. These products may then be grouped with each group represented by the frame group leader, which shall be the option with the highest whole product heat loss. If this approach

is used, the total fenestration product U-factor for the frame group leader shall be used to represent the total fenestration product U-factors for all individual products within that group. For the purpose of determining U-factors, frame groups shall consist only of frame/sash base profile variations consistent with the definition of a product line (section 1.4.1). Individual products from different product lines shall not be combined using frame groups.

When there is more than one cross-section in a product, the three digit total product U-factors shall be compared to determine the "Frame Group Leader". Each total product U-factor shall be based on the individual sections for that product as defined by the manufacturer, using the lowest center-of-glazing U-factor glazing option. The cross-sections in the product with the highest U-factor is the Frame Group Leader.

An acrylic block system with a "Center-of-Glazing Component Test" which utilizes an adaptor between the acrylic block and frame that allows for direct replacement of the standard glass, shall be considered an individual product in the same product line with the "standard glass", as long as all components, including the adaptor, are included in the simulation for the acrylic block glazing system.

1.4.5 Additions to a Product Line

The product line validated simulation procedure (see Section 1.6.1.1) may be used to determine U-factors of additions to a validated product line if the simulated U-factor for the additional product(s) is either higher than the previously computed baseline product U-factor, or is not more than 0.60 W/(m^2℃K) (0.10 Btu/h•ft^2•F) or 20%* lower than a previously simulated baseline product U-factor.

If the simulated U-factor of the addition to the product line is outside these bounds, a new baseline product shall be established and validated by testing.

If a manufacturer introduces a new individual product into multiple product lines (e.g. glazing or spacer options, see section 1.4.3) which has a simulated U-factor more than 0.60 W/(m^2℃K) (0.10 Btu/h•ft^2•F) or 20%* lower than the simulated baseline product U-factor, only one product line with the new individual product shall be tested. If the simulation of the new baseline product validates, then all other product lines using this option shall be validated, and those new individual products may be simulated to obtain U-factors.

1.5 Standard Conditions and Requirements

This section presents standard simulations, tests, and calculations for determining total or component fenestration product U-factors. Read and follow Section 1.6,

* Whichever is greater

Fenestration Product Thermal Properties, before performing any of the tests, simulations, or calculations identified in this section.

1.5.1 Simulation Procedures

The requirements of the NFRC *Simulation Manual* [Reference 2] and of Section 1.5.2.1 shall be used to determine total fenestration product U-factors.

Skylights and other sloped glazing products shall be simulated and rated at a slope of 20 degrees above the horizontal. Tubular daylighting devices shall be simulated and rated with the tube in a vertical orientation (reference Figure 17). All other products shall be simulated and rated in the vertical position.

All calculations shall be based on computer simulations using the latest approved software that includes the gray body diffuse radiation model in compliance to ISO 15099. The following items refer to specific Sections or language in ISO 15099:

- For calculating the overall U-factor per ISO 15099, the area-weighted method as described in ISO 15099, Section 4.1.3 shall be the only method permitted.
- Material conductivities shall be determined in accordance with NFRC 101 and emissivities shall be determined in accordance with the *NFRC Simulation Manual* or more currently adopted NFRC standard.
- Section 7 in ISO 15099 on Shading Systems is currently excluded from NFRC procedures.
- Section 8.2 in ISO 15099 addresses environmental conditions. The following conditions shall be used for the determination of U-factor:

  NFRC Simulation Conditions:
  - T_{in}: Interior ambient temperature of 21 C (70 F).
  - T_{out}: Exterior ambient temperature of -18 C (0 F).
  - V: Wind speed of 5.5 m/s (12.3 mph)
  - $T_{rm,out}=T_{out}$
  - $T_{rm,in}=T_{in}$
  - $I_s=0$ W/m^2 (0 Btu/hr-ft^2-F)

- Section 8.3 in ISO 15099 addresses convective film coefficients on the interior and exterior of the window product. Film coefficients for NFRC modeling are detailed in the NFRC Simulation Manual (reference 2).

- All cross-sections shall include 150 mm (6 in.) of glazing section from the sightline to the end of the glazing section, while maintaining a 63.5 mm (2.5 in.) edge-of-glazing dimension.

The U-factor of a fenestration product may vary by size, depending upon the component materials and the glazing. To simplify the system, ratings are based on a specific model size. The U-factor for the model size in Table 1 shall be representative of all variations in configuration with dual or more lites

(opening/non-opening) for the product type, except as indicated in any applicable footnote. The U-factor for the model size shall be representative of all variations in size and factory assembled operable and fixed units in a common frame.

Factory assembled composite units consisting of two product types (one type being a fixed unit and one being a side-hinged, top or bottom hinged, or sliding) shall be rated as a composite unit to the applicable configuration in Figure 18: Factory Assembled Composite Window Units. This represents multiples of each product type provided that there are no more than two product types. Other composite units require a separate rating for each product type within the composite unit.

For gas fills other than air, the gas fill percentages used in the simulations shall not exceed the values in Reference 2 for a given filling technique.

Non-continuous elements, including but not limited to screws and bolts in sloped glazing and poured and debridged thermal barriers which are not fully debridged, shall be simulated as indicated in Reference 2.

Material conductivities not found in References 2 or 11 shall be determined in accordance with References 3 or 4 or the latest approved NFRC 101 Procedure.

The conductivity results from an ASTM E1530 ("Standard Test Method for Evaluating the Resistance to Thermal Transmission of Thin Specimens of Material by the Guarded Heat Flow Meter Method") test of a thin material may be used as a user defined conductivity for simulation purposes. If ASTM E1530 is not appropriate then ASTM C1114 may be used.

1.5.1.1 Approved Center-of-Glazing Simulation Programs

Approved center-of-glazing software shall be used. NFRC approved software is listed in Reference 5.

1.5.1.2 Approved 2-D Heat Transfer Simulation Programs

Approved 2-D heat-transfer software shall be used. NFRC approved software is listed in Reference 5.

1.5.1.3 Approved Total Fenestration Product U-factor Calculation Procedure

The total fenestration product U-factor calculation procedure can be found in the applicable fenestration product section.

The U-factor shall be reported to 0.05 W/(m^2℃K) (0.01 Btu/h•ft^2•F). If area-weighting is done, software full floating point accuracy shall be used and the final U-factor shall be rounded to two digits following the decimal point. If a spreadsheet or hand calculations are required, all variables used in the formula shall be expressed to at least three (3) significant decimal places and the final U-factor rounded to two digits beyond the decimal point.

1.5.2 Test Procedures

There are two different test procedures used in NFRC 100. Section 1.5.2.1 defines the total fenestration product test procedure, its standard conditions, and requirements. The total fenestration product test procedure shall be used to validate the product line simulations (see Section 1.6.1.1) and shall be used under the testing alternative (see Section 1.6.1.2), which shall be used only if the U-factor for the product cannot be simulated in accordance with Section 1.5.1. Section 1.5.2.2 defines a center-of-glazing component test procedure, which may be used only if the U-factor for the center-of-glazing cannot be simulated in accordance with section 1.5.1.

1.5.2.1 Total Fenestration Product Test Procedure

The NFRC 102: *Test Procedure for Measuring the Steady State Thermal Transmittance of Fenestration Systems* [Reference 1], shall be used to determine tested total fenestration product U-factors. The following conditions also apply:

(a) Test specimen size tested shall be in accordance with Section 1.5.4;
(b) All test specimens shall be tested without screens, removable grilles, or any other applied devices;
(c) All test specimens shall be tested in the vertical position. Skylights and other sloped glazing products shall be tested in a vertical position and simulated at a slope of 20 degrees for rating purposes; and
(d) The test specimen shall not be modified by the testing laboratory, except as allowed in Reference 1 for sealing against air leakage and as required in this section.

1.5.2.2 Center-of-Glazing Component Test Procedure

If the U-factor for the product cannot be simulated in accordance with Section 1.5.1, the test methods in reference 6, using NFRC environmental conditions, shall be used to determine the conductance of the center-of-glazing. Standard film coefficients listed in NFRC Test Procedure shall then be used to calculate the center-of-glazing U-factor. This value shall be used in equation 4 to calculate total product U-factor.

1.5.2.3 Component Substitution

Component substitutions may be made if using approved NFRC simulation tools to verify the performance equivalence to three significant digits. The original certified U-factors shall be used to represent the new product.

(a) For products certified under the Testing Alternative Method, component substitution shall apply only if the simulation laboratory states in the simulation report that the simulation tools are appropriate for the simulation of the components being substituted.

    (i) For spacer substitutions, only the spacer shall be

modeled.

(ii) For glazing system changes, only the center-of-glazing shall be modeled.

1.5.3 Product Line Model Sizes and Configurations for Reporting of U-factors

For each individual product, total fenestration product U-factors shall be reported for the specified configuration at the model size as shown in Table 1.

For sidelite and transom designs that, when area-weighted at the standard NFRC size, have no center-of-glazing area and/or less than 63.5 mm (2.5 in.) edge-of-glazing area, the product shall be area-weighted with each section at the manufacturer's standard frame height (pfd) plus 63.5 mm (2.5 in.) of edge-of-glazing. In no case shall the total product height of transoms be less than 350 mm (14 in.) or the total product width of sidelites less than 400 mm (16 in.). This rule only applies to the widths of sidelites or the heights of transoms.

Table 1: Product types and Model Sizes

Product Type	Opening (X) Non-operating (O)	Model Size (width x height)
Basement	O/X	Rated as the appropriate product type.
Bay or Bow		Rated as the appropriate product type.
Casement – Double[6]	XX	1200 mm x 1500 mm (47 in. x 59 in.)
Casement Single	X	600 mm x 1500 mm (24 in. x 59 in.)
Composite – Fixed beside operable	See Figure 18	1200 mm x 1500 mm (47 in. x 59 in.)
Composite – Fixed over/under operable	See Figure 18	1200 mm x 1500 mm (47 in. x 59 in.)
Dual Action	X	1200mm x 1500 mm (47 in. x 59 in.)
Fixed (includes non-standard shapes)	O	1200 mm x 1500 mm (47 in. x 59 in.)
Garage Door[1]	X	3000 mm x 2400 mm (118 in. x 94 in.)
Greenhouse/Garden[2]	X	1500 mm x 1200 mm (59.1 in. x 47.2 in.)
Hinged Escape	X	1500 mm x 1200 mm (59 in x 47 in)
Horizontal Slider	XO or XX	1500 mm x 1200 mm (59 in. x 47 in.)
Jal/Jal awning	X	1200 mm x 1500 mm (47 in. x 59.in.)
Pivoted	X	1200 mm x 1500 mm (47 in. x 59 in.)
Projecting (Awning- Dual)	XX	1500 mm x 1200 mm (59 in. x 47 in.)
Projecting (Awning – Single)	X	1500 mm x 600 mm (59 in. x 24 in.)
Sidelite	X[2]	600 mm x 2000 mm (24 in. x 79 in.)
Skylight/roof window	X[3]	1200 mm x 1200 mm (47 in. x 47 in.)
Sliding Patio Door with Frame	O, XO or XX	2000 mm x 2000 mm (79 in. x 79 in.)
Glazed Wall/Sloped Glazing	OO[4]	2000 mm x 2000 mm (79 in. x 79 in.)
Swinging Door with Frame	O, X, XO or XX[5]	1000 mm x 2000 mm or 2000 mm x 2000 mm (39 in. x 79 in. or 79 in. x 79 in.)
Door Transom[2]	X	2000 mm x 600 mm (79 in. x 24 in.)
Tropical Awning	X	1500 mm x 1200 mm (59 in x 47 in)
Tubular Daylighting Device	O	350 mm Dia. (14in Dia.)
Vertical Slider	XO or XX	1200 mm x 1500 mm (47 in. x 59 in.)

1 When ratings are determined by physical testing, test samples are allowed to be 2400 mm x 2400 mm (96 in. x 96 in) if the test chamber cannot handle the size listed in Table 1.
2 If not manufactured, use 0 (fixed unit).
3 Fits over or in a 1180 mm (46.5 in x 46.5 in.) opening.
4 Two lites with one vertical mullion. Curtain walls shall be simulated and tested with intermediate verticals as jambs and intermediate horizontals as head/sill frame members. Window walls shall be simulated and tested with intermediate verticals as jambs and standard head and sill members. For rating of curtain walls and window walls, area weight intermediate members based on centerline dimensions. Glazed wall and sloped glazing shall be simulated and tested with standard jamb, head, and sill members (see NFRC 100-Part 2, Site-Built).
5 The single door shall be used to represent all door assemblies (single, double, multiple) unless the manufacturer does not produce a single door, in that case the double door shall be used to represent double and multiple door assemblies.
6 Double casements are to be rated only in the case where a single casement is not manufactured.

1.5.3 Representative Product Size for Testing of Production Line Fenestration Products

For the purposes of testing (see Section 1.5.2), production line units and sizes shall be used. The test specimen size shall be the production line size with the least deviation (*D*) from the model size (see Table 1) as defined by Equation 2:

$$D = \sqrt{\left[\left(W_p - W_m \right)^2 + \left(H_p - H_m \right)^2 \right]}$$

[Equation 2]

Where:

D = deviation in mm (in.)
W_p, H_p = width, height of production size in mm (in.)
W_m, H_m = width, height of model size in mm (in.)

For rectangular fenestration products, the representative sizes reported by the simulation laboratory shall not vary by more than 13.0 mm (0.5 in.) in width or 13.0 mm (0.5 in.) in height [25 mm (1 in.) for doors] from the reported sizes of the tested specimens.

For non-rectangular products, the simulated product area shall meet the following relationship with the tested specimen area:

$$A_{test} - C \cdot \left(W_m + H_m \right) \leq A_{sim} \leq A_{test} + C \cdot \left(W_m + H_m \right)$$

[Equation 3]

Where:

A_{sim} = area of product simulated in mm^2 ($in.^2$)
A_{test} = area of specimen tested in mm^2 ($in.^2$)
C = a constant, 25 mm (1 in.)
W_m, H_m = width, height of model size in mm (in.)

1.5.5 Equivalent

Simulated and tested U-factors for a given total fenestration product shall be considered equivalent if the agreement between the two numbers is within the ranges in Table 2.

Table 2: Equivalence

Simulated U-factor	Accepted Difference Between Tested and Simulated U-factor
1.7 W/(m^2•K) (0.3 Btu/h•ft^2•F) or less	0.17 W/(m^2•K) (0.03 Btu/h•ft^2•F) or less
Greater than 1.7 W/(m^2•K) (0.3 Btu/h•ft^2•F)	10% of Simulated U-factor

1.6 Fenestration Product Thermal Properties

This section presents and references methods for determining specific fenestration product heat transfer properties or quantities used in the determination of these properties.

1.6.1 Total Fenestration Product U-factors for Model Sizes

For a given product line, list all individual products and the associated model size U-factors (see Section 1.5.3). The model size matrix of U-factors for a given product line shall be outlined as follows:

	U-factor for Model Size
Individual Product #1	
.	
.	
.	
Last Individual Product	

This matrix shall include all individual products within a product line which are available from the manufacturer, including but not limited to the number of glazing layers, glazing types, glazing coatings, gas-fills, gap widths, spacer types, and use of dividers. See Section 1.4.1 for the definition of a product line and Section 1.4.2 for the definition of individual products.

In order to determine total fenestration product U-factors for all the entries in this matrix, use the product line validated simulation procedure, presented in Section 1.6.1.1. The testing alternative, presented in Section 1.6.1.2, may only be used to determine the U-factor for an individual product(s) within a product line if that individual product(s) cannot be simulated in accordance with Section 1.5.1.

Thus, the only time a product line may contain tested as well as simulated total fenestration product U-factors shall be when an accredited simulation laboratory states in the simulation report that it cannot simulate an individual product(s) to a reasonable accuracy. In addition, the written permission of NFRC shall be required.

1.6.1.1 Product Line Validated Simulation Procedure

(a) Determine the representative size matrix of U-factors. List all individual products and associated representative sizes (see Section 1.5.3) within a product line. The representative size matrix of U-factors for a product line is given as follows:

	U-factor for Model Size
Individual Product #1	
.	
.	
.	
Last Individual Product	

(b) Compute the total fenestration product U-factor for the baseline product in the representative size matrix of U-factors. Using the approved total fenestration product U-factor calculation procedure (see Section 1.5.1), compute the U-factor for the baseline product (see Section 1.4.3).

*[**Note:** Compute as many U-factors in this representative size matrix as is necessary to definitely determine the baseline product.]*

(c) Test the baseline fenestration product using the approved total fenestration product U-factor test procedure in Section 1.5.2.1.

(d) Validation of the simulation procedure. If the simulated and tested U-factors for the baseline product are equivalent, as defined in Section 1.5.5, then the computational procedure presented in Section 1.5.1 shall be considered validated for all the products in the product line. The approved total fenestration product U-factor calculation procedure presented in Section 1.5.1 shall then be used to determine U-factors for the model size matrix of U-factors of Section 1.6.1. These are the values that shall be reported. If the simulated and tested U-factors for the baseline product are not equivalent, as defined in Section 1.5.5, then the alternative test procedure presented in Section 1.6.1.2 may be used for all products within the product line with written permission from NFRC.

1.6.1.2 Testing Alternative

If an Individual Product cannot be simulated in accordance with Section 1.5.1, the test procedure found in Section 1.5.2.1 shall be used to determine the U-factors of the individual fenestration product(s) for the size defined in Table 1.

The test specimen size shall be the size with the lowest deviation determined from Equation 2. If the test specimen cannot be fabricated at the Table 1 size, the tested U-factor shall be adjusted to the Model size using the following:

$$U_{mod} = (U_{rep} \times A_{rep}) / A_{mod}$$

Where

U_{mod} = U–factor at model size
U_{rep} = U-factor at representative size (test size)
A_{rep} = Area at representative size
A_{mod} = Area of Model size

1.6.2 Total Fenestration Product U-factors for Non-Model Sizes

Either the product line validated simulation procedure or the testing alternative may be used to evaluate the total fenestration product U-factor for size configurations other than the model size for purposes other than certification.

1.7 Custom Product Rating

A custom product is an NFRC individual product, which meets all of the following criteria:

A custom product shall be composed of unique frame/sash components not covered within an existing standard product line's U-factor matrix.

1. The specific configuration of a custom product shall not be offered publicly in a manufacturer's catalog or similar literature.
2. Less than 500 units shall be produced annually, or
3. If more than 500 units are produced annually, they shall be produced as part of one purchase order.

U-factors for custom products, which meet all three criteria above, may be represented by U-factor ratings generated for a similar stock individual product made of the same product type and materials. A simulation analysis from an NFRC-certified simulator employed by an NFRC-accredited Simulation Laboratory confirming that the custom product's U-factor is equal to or lower than the stock product shall be provided to the NFRC or NFRC’s designated representative.

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2.0 Windows and Sliding Glass Doors

This section presents and references methods for determining specific product system heat transfer properties or quantities used in the determination of these properties. At this time, the scope of these properties is limited to total product system U-factor.

2.1 Product line

This section presents additional product line details specific to windows and sliding glass doors.

Sash kits for any product type shall be rated using one of two options:

Option 1: Simulate and test (if required) in a default frame (see Figure 15) of similar material and design as the proposed installation.

Option 2: Sash kits that are identical in material and design as a manufacturer's rated product line may use the same ratings provided an NFRC-accredited simulation laboratory states that the frame qualifies as a default frame per option 1.

2.2 Approved Total Fenestration Product U-factor Calculation Procedure

The total fenestration product U-factor shall be calculated as outlined below:

(a) Determine all of the following, as applicable:

(1) Center-of-glazing U-factor per the total product height procedure as defined in Reference 2 using an approved center-of-glazing simulation program, or the approved center-of-glazing conductance test procedure given in Section 1.5.2.2;

(2) Edge-of-glazing U-factor using an approved 2-D heat transfer simulation program;

(3) Divider U-factor using an approved 2-D heat transfer simulation program;

(4) Edge-of-divider U-factor using an approved 2-D heat transfer simulation program;

(5) Frame U-factor using an approved 2-D heat transfer simulation program; and

(6) The component areas of:
- Center-of-glazing area
- Edge-of-glazing area
- Divider area
- Edge-of-divider
- Frame area
- Projected fenestration product area.

(b) Perform the following calculations as shown in Equation 4:

(1) The U-factor shall be reported to 0.05 W/(m^2 ℃K) [0.01 Btu/(h•ft^2•F)]

(2) Multiply the center-of-glazing, edge-of-glazing, divider, edge-of-divider, and frame U-factors by their corresponding areas;

(3) Total these five quantities; and

(4) Divide this total by the projected fenestration product area to produce simulated total fenestration product U-factors for all the fenestration products in the matrix of required U-factors (see Section 1.6.1).

$$U_t = \frac{\left[\sum \left(U_f \cdot A_f\right) + \sum \left(U_d \cdot A_d\right) + \sum \left(U_e \cdot A_e\right) + \sum \left(U_{de} \cdot A_{de}\right) + \sum \left(U_c \cdot A_c\right)\right]}{A_{pf}}$$

[Equation 4]

Where:

U_t = Total product U-factor
A_{pf} = Projected fenestration product area
U_f = Frame U-factor
A_f = Frame area
U_d = Divider U-factor
A_d = Divider area
U_e = Edge-of-glazing U-factor
A_e = Edge-of-glazing area
U_{de} = Edge-of-divider U-factor
A_{de} = Edge-of-divider area
U_c = Center-of-glazing U-factor
A_c = Center-of-glazing area

3.0 Side-hinged Exterior Doors

This section presents and references methods for determining specific side hinged exterior door system heat transfer properties or quantities used in the determination of these properties. At this time, the scope of these properties is limited to total door system U-factor.

3.1 Product line

A given series of entrance door systems defined by skin material, core material, and edge of door construction that differ only in:

(1) Size;
(2) Panel and cut out configurations;
(3) The replacement of core and/or panel area with glazing system;
(4) Center-of-lite characteristics and edge-of-lite characteristics such as glazing types, gap widths, glazing lite areas, use of dividers, use of spacers, glazing coatings, gas fills;
(5) Opening/non-opening configurations, e.g. X, O, XX, XO, OXXO etc.;
(6) In-swing or out-swing operation;
(7) Door slab changes where one component of the same physical shape with a thermal conductivity that does not differ by more than a factor of 10;
(8) Frame components, e.g. headers, jambs, and threshold; and
(9) Variations in frame and/or door interior/exterior finish, paint, varnish or stain do not constitute different product lines provided that each of these variations does not change the surface emittance by more than 0.10.

3.2 Individual Products

Products with multiple sill options, where the sill design changes to accommodate different installation requirements, made of the same materials type shall be different individual products within the same product line.

3.3 Simplifications to a Product Line

This section presents rules that may be used to reduce the number of simulations of individual products necessary to represent a product line. These rules may be used either with the product line validated simulation procedure (see Section 1.6.1.1) or with the testing alternative (see Section 1.6.1.2).

Each door of a double door or swinging patio unit shall be rated as the single door of the same style or model. For opaque doors with flat raised or embossed panels, a 6-panel layout shall be representative of all panel doors within a product line of the same panel thickness. For non-wood doors only, this layout may also be considered representative of flush doors. See Figure 6 for a typical 6-panel layout.

For representative production line specimens, doors, sidelites and transoms of the complete system (slab, frame, and sill) shall be within +/- 25 mm (1 in.) of the appropriate model size listed in Table 1.

If a manufacturer wishes to simulate a door slab in both the wood and steel default frames (or proprietary wood and steel frames), the manufacturer may either simulate all individual products in the matrix, or develop an add-on for the steel frame. To develop the steel frame add-on, all the individual products in the matrix shall be simulated in the wood default frame. The best performing product in the wood frame shall then be simulated in the steel frame. The difference between these two U-factors shall be the steel frame add-on. The U-factor for the remaining products in the steel frame shall be the U-factor for that product in the wood frame plus the steel frame add-on.

For composite doors, a manufacturer may also choose to simulate all glazing options in the default door lite frame to represent all their door lite frames.

For sill options with a higher U-factor than the default sill, an add-on for the sill may be determined by simulating the best performing system with both sills and using the difference as a sill add-on.

3.4 Total Door System U-factors for Model Sizes

Total Fenestration Product U-factors for model sizes shall be calculated in accordance with Section 1.6.1.

To reduce the number of individual products necessary to represent a product line refer to the guidelines prescribe in Section 1.4.4 and Section 3.3.

Products of the same style or model number within the same product line, which differ from one another in size only, shall be assumed to have the same U-factor as the model size listed in Table 1. Separate calculations or testing on these products shall not be required.

In simulating U-factors, continuous single pane stained glass may be assumed to have the same properties as clear glass of the same glass thickness. This is also true for continuous single pane stained glass, which is the middle layer of a triple glazed window, provided that the cavity between the stained glass and the surrounding glass is greater than 3.00 mm (0.118 in.). If the cavity between the stained glass and the surrounding glass is less than 3.00 mm (0.118 in), either each stained glass pattern shall be considered to be a different individual product, or the optional caming pattern as shown in the tables below may be used to represent all stained glass caming patterns. The default caming profile may be used to represent the caming. If the stained glass is not continuous it shall not be considered in the U-factor analysis of the door. A triple glazed door with non-continuous stained glass as the middle layer shall be simulated as though it were double-glazed, regardless of the cavity thickness between the stained glass and the surrounding glass. Products may be grouped based on glazing size. These groups shall be unglazed, 1/4, 1/2, 3/4, and full lite. Unglazed slabs shall be solid doors, either flush or panel doors. The glazing designations shall be defined as follows:

	Flush Doors			Embossed, Stile and Rail Panel Doors	
Individual Product	**For Doors with**	**Simulated or Test as**	**Optional Caming Pattern(1)**	Glass inserts for a 6-panel door	Optional Caming Pattern (1)
1/4 glazing	0.265 m^2 (410 in^2) or less	560 mm x 480 mm (22 in. x 19 in.)	5 Vert 3 Hor	replace upper two panels and intermediate stiles and rails	< 610 mm (24 in.) use 5 Vert
1/2 glazing	0.265 m^2 - 0.581 m^2 (410-900 in^2)	560 mm x 1040 mm (22 in. x 41 in.)	5 Vert 8 Hor	replace upper four panels and intermediate stiles and rails	610 mm (24 in.) use 6 Vert
3/4 glazing	0.581 m^2 - 0.710 m^2 (900-1100 in^2)	560 mm x 1270mm (22 in. x 50 in.)	5 Vert 10 Hor	replace lower four panels and intermediate stiles and rails	For horiz. Use the formula: (H/4.5) – 1
full glazing	0.710 m^2 (1100 in^2) or more	560 mm x 1625 mm (22 in. x 64 in.)	5 Vert 13 Hor	replace all panels and intermediate stiles and rails	

	Flush Sidelites			Embossed, Stile and Rail Panel Sidelites	
Individual Product	**For Sidelites with**	**Simulated or Test as**	**Optional Caming Pattern(1)**	Glass inserts for a 6-panel door	Optional Caming Pattern (1)
1/4 glazing	<0.042 m^2 (65 in^2)	200 mm x 200 mm (8 in. x 8 in.)	1 Vert 1 Hor	replace upper panel and intermediate stiles and rails	Vert 1
1/2 glazing	0.042 m^2 - 0.226 m^2 (65 in^2 to 350 in^2)	200 mm x 915 mm (8 in x 36 in)	1 Vert 8 Hor	replace upper two panels and intermediate stiles and rails	For horiz. use the formula: (H/4.5) – 1
3/4 glazing	0.226 m^2 - 0.297 m^2 (350 in^2 to 460 in^2)	200 mm x 1270 mm (8 in. x 50 in.)	1 Vert 10 Hor	replace lower two panels and intermediate stiles and rails	
full glazing	> 0.297 m^2 (460 in^2)	200 mm x 1625 mm (8 in. x 64 in.)	1 Vert 13 Hor	replace all panels and intermediate stiles and rails	

(1) Note: When adding caming to the glazing option in the patterns as designated, the center-of-glazing becomes non-existent and the entire glazing becomes edge-of-lite that may be less than 63 mm (2.5 in.).

(2) H=height

Sidelites with lites shall be grouped as separate Individual Products at the lite sizes indicated in the Table below.

Simulation shall be performed on a single rectangular shaped lite at the sizes in the Table below. The Baseline Product shall have a lite size that is closest to the size indicated in the Table below and be within the area range specified. Different glazing options shall be represented by separate Individual Products unless grouped per the requirements in Section 1.4.4.

Individual Product	for sidelites with	Simulate or Test Glazing Sizes
1/4 glazing	<0.042 m^2 (65 in^2)	200 mm x 200 mm (8 in. x 8 in.)
1/2 glazing	>0.042 m^2 or < 0.226 m^2 (65 in^2 or < 350 in^2)	200 mm x 915 mm (8 in. x 36 in.)
3/4 glazing	>0.226 m^2or < 0.297 m^2 (350 in^2 to 450 in^2)	200 mm x 1270 mm (8 in. x 50 in.)
Full glazing	>0.297 mm^2 (450 in^2)	200 mm x 1625 mm (8 in. x 64 in.)

3.5 Approved Total Exterior Door System U-factor Calculation Procedure

The total door system U-factor shall be calculated as outlined below:

(a) Determine all of the following, as applicable:

(1) Panel(s) U-factor using the approved 2-D heat transfer computational program;

(2) Door core U-factor using the approved 2-D heat transfer computational program;

(3) Center-of-lite U-factor per the total product height procedure as defined in Reference 2 using the approved center-of-lite computational program, with input as needed from the approved center-of-lite conductance test procedure given in Section 1.5.1.2;

(4) Edge-of-lite U-factor using the approved 2-D heat transfer computational program;

(5) Divider U-factor using the approved 2-D heat transfer computational program;

(6) Edge-of-divider U-factor using the approved 2-D heat transfer computational program;

(7) Lite frame U-factor using the approved 2-D heat transfer computational program;

(8) Frame U-factor using the approved 2-D computational program;

(9) Edge-of-panel U-factor using the approved 2-D computational program and;

(10) The component areas of:

- Frame area

- Lite frame area
- Divider area
- Edge-of-divider area
- Edge-of-lite area
- Center-of-lite area
- Door core area
- Panel area
- Edge-of-panel area
- Projected total exterior door system area

(b) Perform the following calculations as shown in Equation 5:

(1) Multiply the center-of-lite, divider, edge-of-lite, edge-of-divider, panel, door core, lite frame, edge-of-panel, and frame U-factors by their corresponding areas;

(2) Total these nine quantities; and

(3) Divide this total by the projected total exterior door system area to produce computed total door system product U-factors for all the door systems in the matrix of required U-factors.

$$U_t=[(U_f*A_f)+(U_{lf}*A_{lf})+(U_d*A_d)+(U_{de}*A_{de})+(U_{eg}*A_{eg})+(U_c*A_c)+(U_{dc}*A_{dc})+(U_p*A_p)+(U_{ep}*A_{ep})]/A_{pf}$$

[Equation 5]

Where:

U_t = Total door system U-factor
U_f = Frame U-factor
A_f = Frame area
U_{lf} = Lite frame U-factor
A_{lf} = Lite frame area
U_d = Divider U-factor
A_d = Divider area
U_{de} = Edge-of-divider U-factor
A_{de} = Divider area
U_{eg} = Edge-of-lite U-factor
A_{eg} = Edge-of-lite area
U_c = Center-of-lite U-factor
A_c = Center-of-lite Area
U_{dc} = Door core U-factor
A_{dc} = Door core area
U_p = Panel U-factor
A_p = Panel area
U_{ep} = Edge-of-panel U-factor
A_e = Edge-of-panel area
A_{pf} = Projected total exterior door system area

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4.0 Skylights

This section presents and references methods for determining specific skylight system heat transfer properties or quantities used in the determination of these properties. At this time, the scope of these properties is limited to total skylight system U-factor. For additional simulation parameters see reference 2.

4.1 Orientation

Skylights shall be simulated and rated at a slope of 20° above the horizontal. Ratings for test only products shall be converted to the 20° slope from the vertical position by multiplying the tested value at vertical by 1.19.

4.2 Rating size

The skylight sizes listed in Table 1 are based on the center of rafter to center of rafter dimension. The 1200 mm x 1200 mm (47 in. x 47 in.) size is representative of an 1180.0 mm x 1180.0 mm (46.5 in. x 46.5 in.) rough opening.

4.3 Skylight area

The U-factor for all skylights is based on the projected fenestration product area of the rough opening, which is 1180.0 mm x 1180.0 mm (46.5 in. x 46.5 in.).

4.4 Product line

If a skylight can be installed using more than one of the installation methods listed below, the skylight product line shall include all the pertinent options as individual products. The method in which skylights are mounted will affect the U-Factor of the skylight. Mounting variations include:

1. Inset Mount: where the curb of the skylight extends into the rough opening in the roof.
2. Curb Mount where the outside of the curb is equal to the rough opening in the roof and
3. Curb mount where the inside of the curb is equal to the rough opening in the roof.

Variations of each mounting type may occur.

4.5 Curb

Curb mounted skylights that do not have an attached integral curb when manufactured shall be simulated and tested installed on a nominal 2 x 4 (actual size 40.0 mm x 90.0 mm (1.5 in. x 3.5 in.) wood curb made from Douglas Fir, with no knots.

4.6 Approved Total Fenestration Product U-factor Calculation Procedure

The total fenestration product U-factor shall be calculated as outlined below:

(a) Determine all of the following, as applicable:

(1) Center-of-glazing U-factor per the total product height procedure as defined in Reference 2 using an approved center-of-glazing simulation program, with input as needed from the approved center-of-glazing conductance test procedure given in Section 1.5.2.2;

(2) Edge-of-glazing U-factor using an approved 2-D heat transfer simulation program;

(3) Divider U-factor using an approved 2-D heat transfer simulation program;

(4) Edge–of-divider U-factor using an approved 2-D heat transfer simulation program;

(5) Frame U-factor using an approved 2-D heat transfer simulation program; and

(6) The component areas of:

- Center-of-glazing area
- Divider area
- Edge-of-glazing area
- Edge-of-diver area
- Frame area
- Projected fenestration product area.

(b) Perform the following calculations as shown in Equation 6:

(1) The U-factor shall be reported to 0.05 W/(m^2•K) (0.01 Btu/h•ft^2•F).

(2) Multiply the center-of-glazing, edge-of-glazing, divider, edge-of-divider, and frame U-factors by their corresponding areas.

(3) Total these five quantities.

(4) Divide this total by the projected fenestration product area to produce simulated total fenestration product U-factors for all the fenestration products in the matrix of required U-factors (see Section 1.6.1).

$$U_t = \frac{\left[\sum \left(U_f \cdot A_f\right) + \sum \left(U_d \cdot A_d\right) + \sum \left(U_e \cdot A_e\right) + \sum \left(U_{de} \cdot A_{de}\right) + \sum \left(U_c \cdot A_c\right)\right]}{A_{pf}}$$

[Equation 6]

Where:

U_t = Total Product U-factor
A_{pf} = Projected Fenestration Product Area
U_f = Frame U-factor

A_f = Frame Area
U_d = Divider U-factor
A_d = Divider Area
U_e = Edge-of-glazing U-factor
A_e = Edge-of-glazing area
U_{de} = Edge-of-divider U-factor
A_{de} = Edge-of-divider Area
U_c = Center-of-glazing U-factor
A_c = Center-of-glazing area

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5.0 Tubular Daylighting Devices

This section presents and references methods for determining specific tubular daylighting device system heat transfer properties or quantities used in the determination of these properties. For additional simulation parameters see reference 2. At this time the only ratings available for these products are based on computer simulations. When NFRC can determine an appropriate test procedure a Technical Interpretation will be issued. Simulations shall be performed per Reference 13 using standard model conditions stated in Section 5.5.

5.1 Orientation

U-Factors for tubular daylighting devices shall be rated, with the tube in a vertical orientation (reference Figure 17). The diffuser is simulated attached to the ceiling, the tubular section located in the attic space connecting the interior diffuser to the exterior dome, and the exterior dome mounted to the roof deck. Therefore the heat flow shall be in the vertical direction. Standardized rating conditions are defined in Section 5.5.

5.2 Rating sizes

The tubular daylighting device size listed in Table 1 is based on a standardized 350 mm (14 in.) diameter tube opening.

5.3 Tubular Daylighting Device area

The U-factor for all tubular daylighting devices is based on the tube diameter and the corresponding area associated with that diameter, which is 0.1 m^2 (1 ft^2). This area shall be used when calculating the total product U-factor.

5.4 Product Line

A tubular daylighting device product line shall only consist of individual products of the same tube material, exterior dome material and interior diffuser material.

5.5 Standard Modeling Conditions

1. 750 mm (30 in.) shaft length (interior ceiling line to exterior roof line).
2. 350 mm (14 in.) diameter shaft opening.
3. Convective correlation in the shaft air cavity per Reference 13.
4. Ceiling insulation shall be simulated as per Reference 13, [250 mm (10 in.) total depth], which is represented as an adiabatic boundary.
5. An exterior 13.0 mm (0.5 in.) thick plywood roof deck.
6. ASHRAE attic space boundary conditions on the exposed surface of the vertical shaft material, from the top of the insulation material to the underside of the 13.0 mm (0.5 in.) plywood roof deck, modeled according to the procedures in Reference 13.
7. Exterior boundary conditions applied to the exposed surface of the dome.
8. Bottom of the tubular skylight covered with a light diffusing plate (manufacturer specific).

5.6 Approved Total Fenestration Product U-factor Calculation Procedure

The total tubular delighting system U-factor shall be calculated as outlined below:

(a) Use the tubular shaft area.

(b) Perform the following calculations as shown in Equation 7:

(1) The U-factor shall be reported to 0.05 W/(m^2•K) (0.01 Btu/h•ft^2•F).

(2) Calculate the total heat flow through the diffuser area exposed to the indoor environment, Q_d.

(3) Divide this total heat flow by the projected total tubular daylighting device interior opening area to produce computed total product U-factor.

$$U_t=Q_d/A_{pf}$$

[Equation 7]

Where:

U_t = Total tubular daylighting system U-factor
Q_d = Total heat flow through the diffuser area exposed to the indoor environment
A_{pf} = Projected total tubular daylighting device shaft interior opening area

6.0 Vehicular Access Doors (Garage Doors)

This section presents and references methods for determining specific residential garage door system heat transfer properties or quantities used in the determination of these properties. At this time, the scope of these properties is limited to total garage door system U-factor. For additional simulation parameters see reference 2.

6.1 Product line

A given series of garage door systems defined by skin material, core material, and edge of garage door construction that differ only in:

1. Size;
2. Solid panel and panel cut out configurations;
3. The replacement of core and/or panel area with glazing system;
4. Center-of-lite characteristics and edge-of-lite characteristics such as glazing types, gap widths, glazing lite areas, use of dividers, use of spacers, glazing coatings, gas fills;
5. Panel/slab changes where one component of the same physical shape with a thermal conductivity that does not differ by more than a factor of 10
6. Jamb track or hardware components;
7. Variations in panel/slat interior/exterior finish, paint, varnish or stain do not constitute different product lines provided that each of these variations do not change the surface emittance by more than 0.10; and
8. Variations in end stile design, top edge, and bottom edge panel designs.

6.2 Individual Products

An individual product, in a product line, shall be, those products that comply with the requirements per Section 6.1.

6.3 Standard Modeling Conditions

1. Garage doors that consist of panels shall have the U-factor determined using four (4) panels, each being 600 mm (24 in.) in height, with the following designation: Panel # 1 shall be the bottom most panel and panel #4 shall be the uppermost panel. The bottom panel, top panel, and one intermediate panel shall be modeled.
2. For garage doors that are of the ‘roll-up’ type, the slat height shall be 50 mm (2 in.) and shall have 48 slats for the determination of the U-factor. The bottom panel, the top panel, and the intermediate panels shall be modeled per manufacturer drawings.
3. The bottom and top rails shall be identical for each individual product in a product line.
4. For four panel doors with glazing options, the glazing shall be per the manufacturer’s design. No dividers shall be considered for modeling purposes.

6.4 Approved Total Fenestration Product U-factor Calculation Procedure

The total garage door system U-factor shall be calculated as outlined below:

(a) Determine all of the following, as applicable:

(1) Panel(s) U-factor using the approved 2-D heat transfer computational program;

(2) Door core U-factor using the approved 2-D heat transfer computational program;

(3) Center-of-glazing U-factor per the total product height procedure as defined in Reference 2 using the approved center-of-lite computational program, with input as needed from the approved center-of-lite conductance test procedure given in Section 1.5.1.2;

(4) Edge-of-glazing U-factor using the approved 2-D heat transfer computational program;

(5) Lite frame U-factor using the approved 2-D heat transfer computational program;

(6) Edge-of-panel U-factor using the approved 2-D computational program;

(7) Stile U-factor using the approved 2-D computational program; and

(8) The component areas in square feet, to the nearest 0.001 m^2 (0.010 ft^2) of:

* Lite frame area
* Edge-of-glazing area
* Center-of-glazing area
* Door core area
* Panel area
* Edge-of-panel area (top and bottom)
* Stile area (ends)
* Projected total exterior door system area

(b) Perform the following calculations as shown in Equation 8:

(1) Multiply the center-of-glazing, edge-of-glazing, panel, door core, lite frame, edge-of-panel and stile U-factors by their corresponding areas;

(2) Total these seven quantities; and

(3) Divide this total by the projected total exterior garage door system area to produce computed total garage door system product U-factors for all the door systems in the matrix of required U-factors.

$$U_t=[(U_{lf}*A_{lf})+(U_e*A_e)+(U_c*A_c)+(U_{dc}*A_{dc})+(U_p*A_p)+(U_{ep}*A_{ep}))+(U_{es}*A_{es})]/A_{pf}$$

[Equation 8]

Where:

U_t = Total Door System U-factor
U_{lf}= Lite frame U-factor
A_{lf}= Lite frame area
U_e= Edge-of-glazing U-factor
A_e= Edge-of-glazing area
U_c= Center-of-glazing U-factor
A_c= Center-of-glazing area
U_{dc}= Door core U-factor
A_{dc}= Door core area
U_p= Panel U-factor
A_p= Panel area
U_{ep}= Edge-of-panel U-factor
A_{ep}= Edge-of-panel Area
U_{es}= End stile U-factor
A_{es}= End stile area
A_{pf}= Projected total door system area

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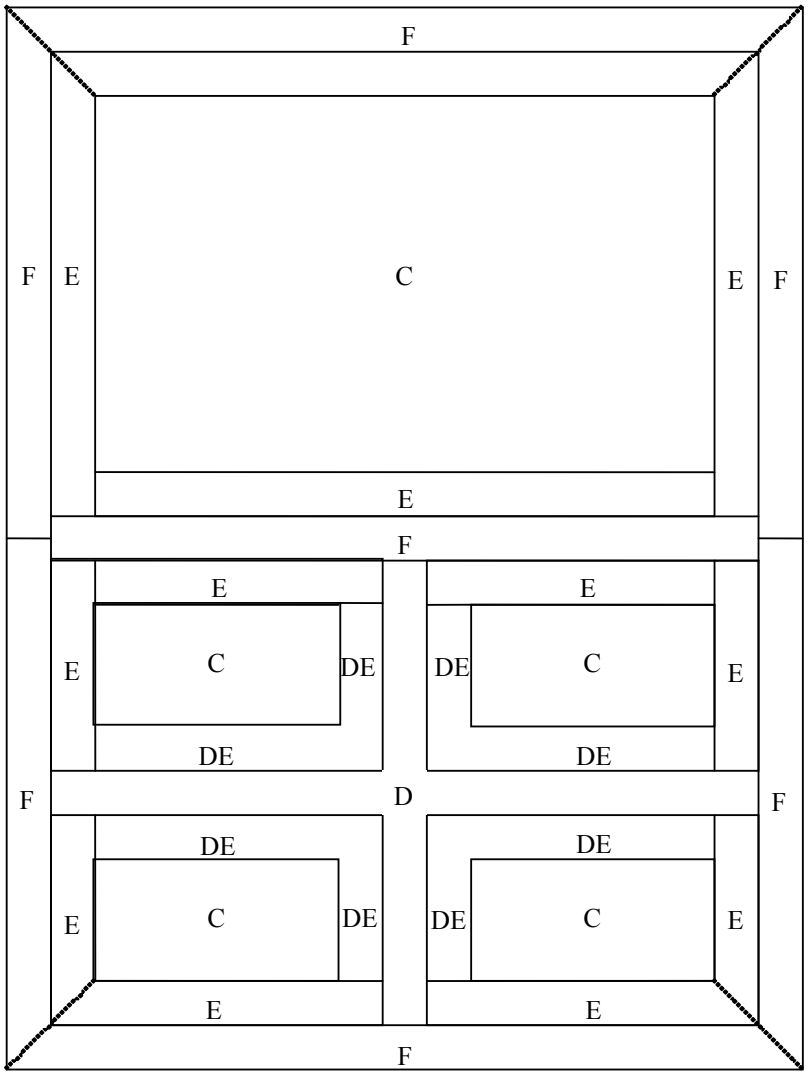
7.0 Figures

Figure 1: Fenestration Product Schematic—Vertical Elevation

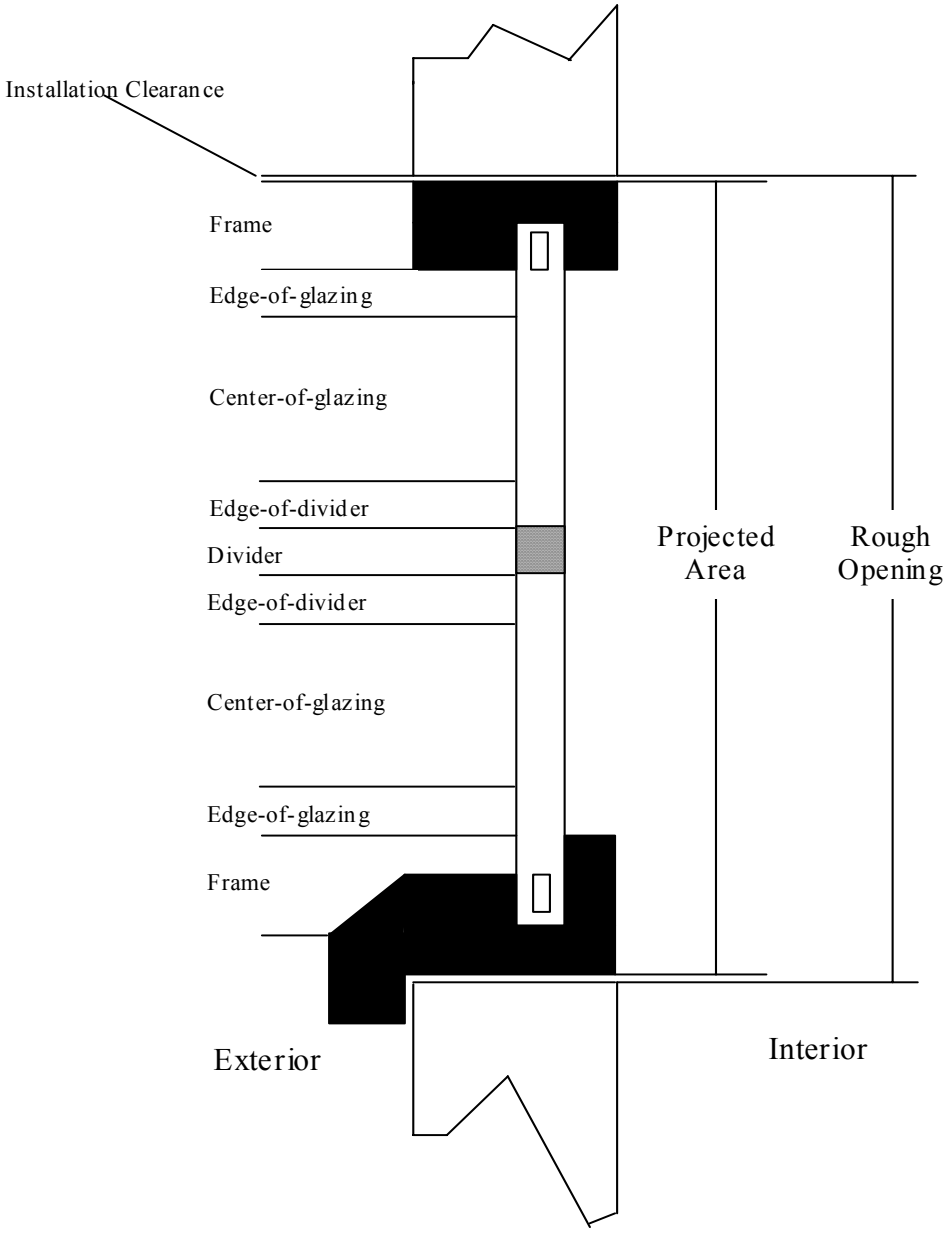


LEGEND

C	Center-of-glazing
E	Edge-of-glazing
F	Frame
D	Divider
DE	Edge-of-divider

Center-of-glazing, edge-of-glazing, divider, edge-of-divider and frame areas for a typical fenestration product. Edge-of-glazing and edge-of-divider areas are 63.5 mm (2.5 in.) wide. The sum of these component areas equals the total projected fenestration product area.

Figure 2: Fenestration Product Schematic—Vertical Section



Center-of-glazing, edge-of-glazing, divider, edge-of-divider, and frame areas for a typical fenestration product. Edge-of-glazing and edge-of-divider areas are 63.5 mm (2.5 in.) wide. The projected fenestration product area is the rough opening less installation clearances.

Figure 3: Divider Height and Divider Width

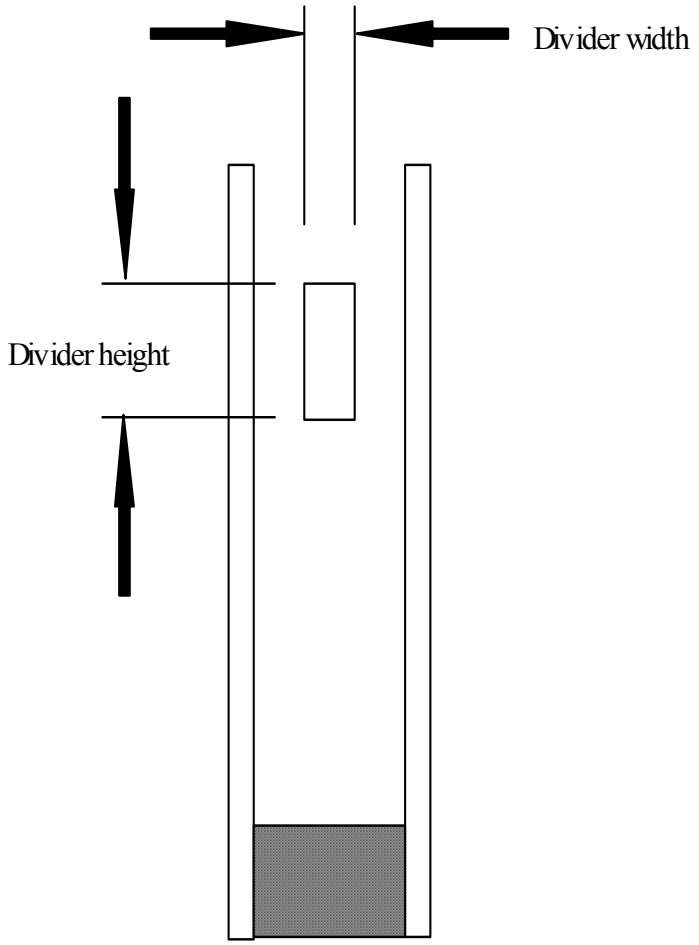


FIGURE 4: Exterior Steel/Composite Door System Area Schematic—Vertical Elevation

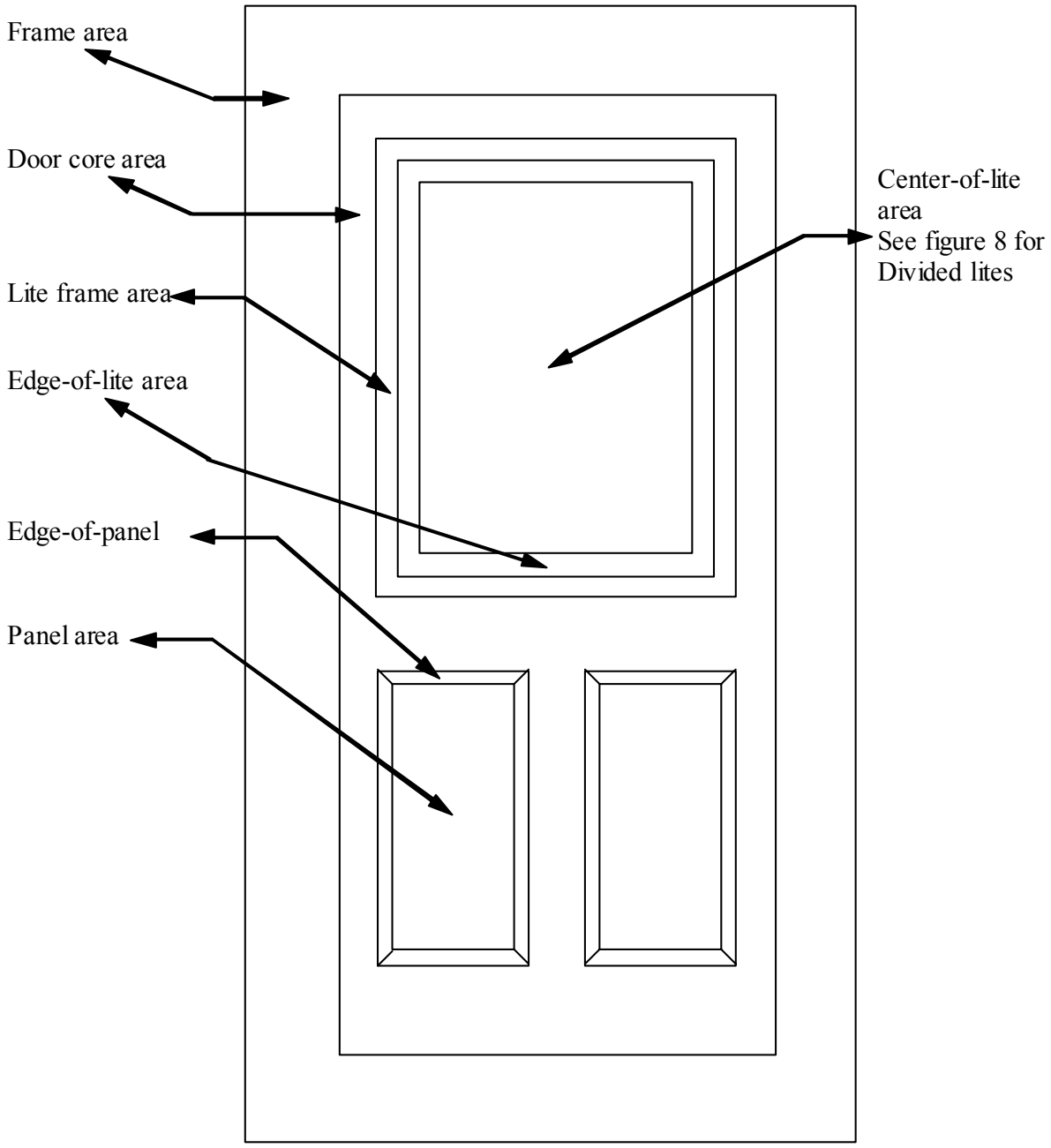
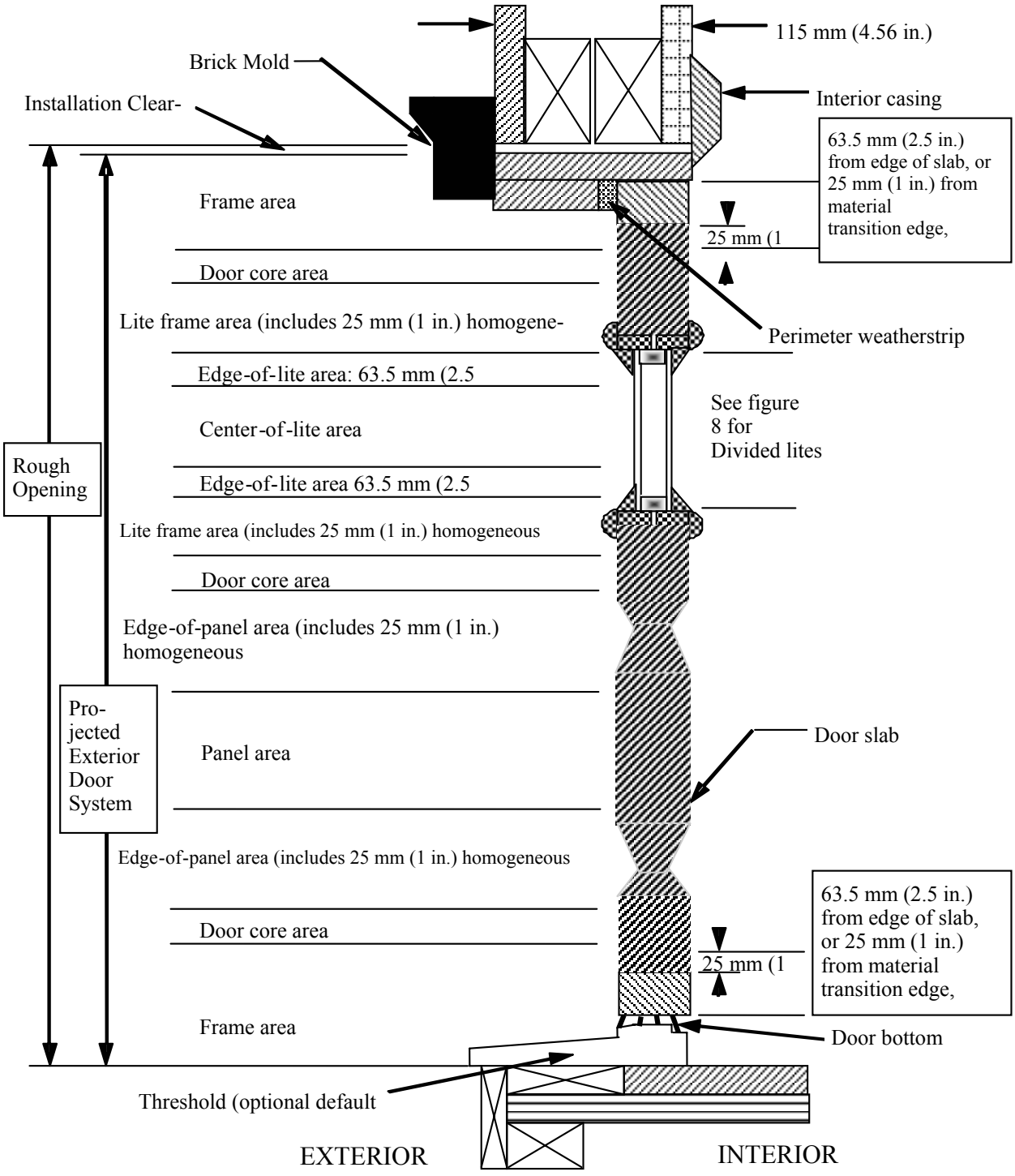


FIGURE 5: Exterior Steel/Composite Door System Area Schematic — Vertical Elevation



The projected door product area is the rough opening area less installation clearances. Side -lite area schematic may be identical or similar without perimeter weatherstrip and bottom sweep.

FIGURE 6: Exterior Wood Door System Area Schematic — Vertical Elevation

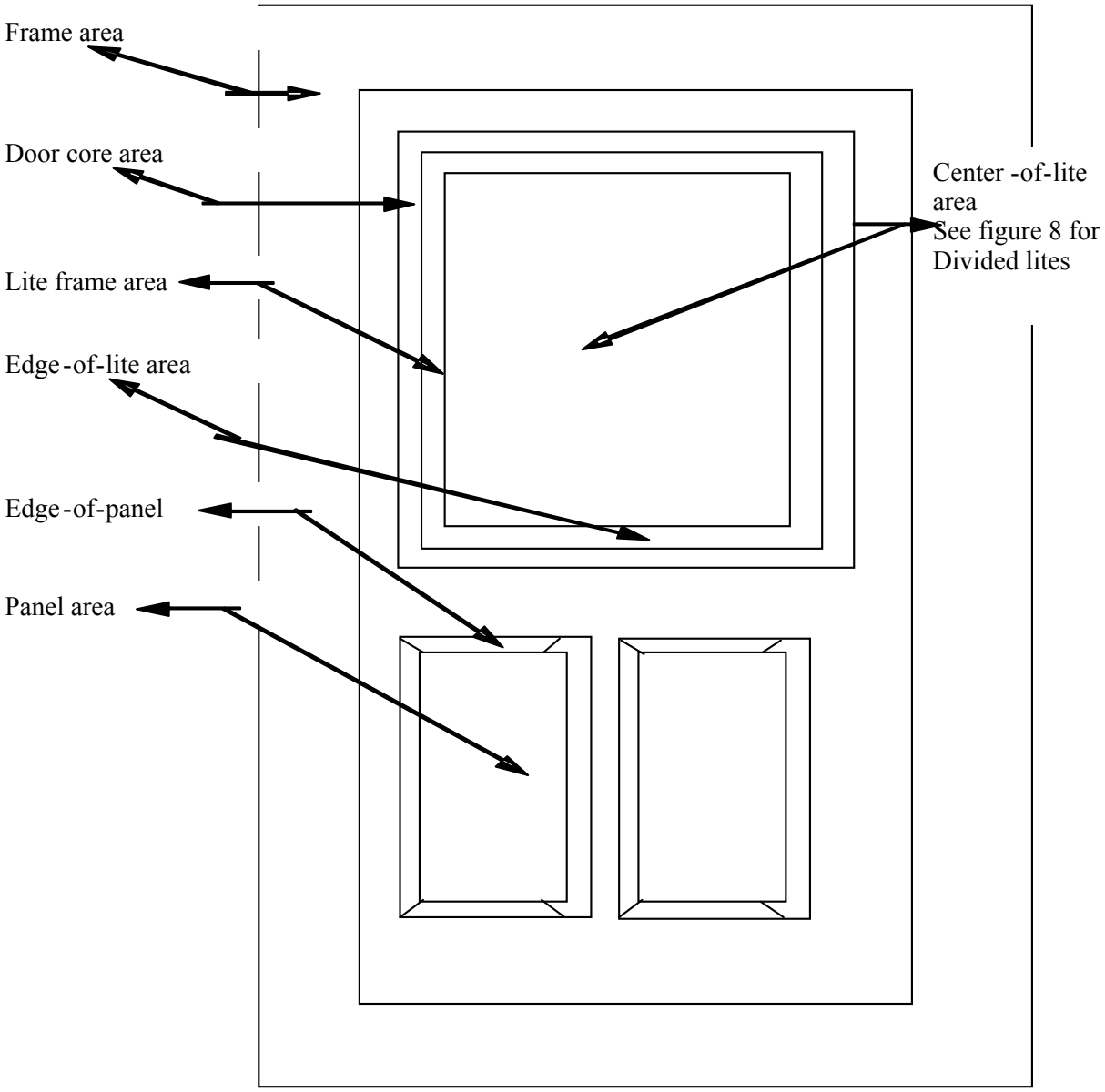
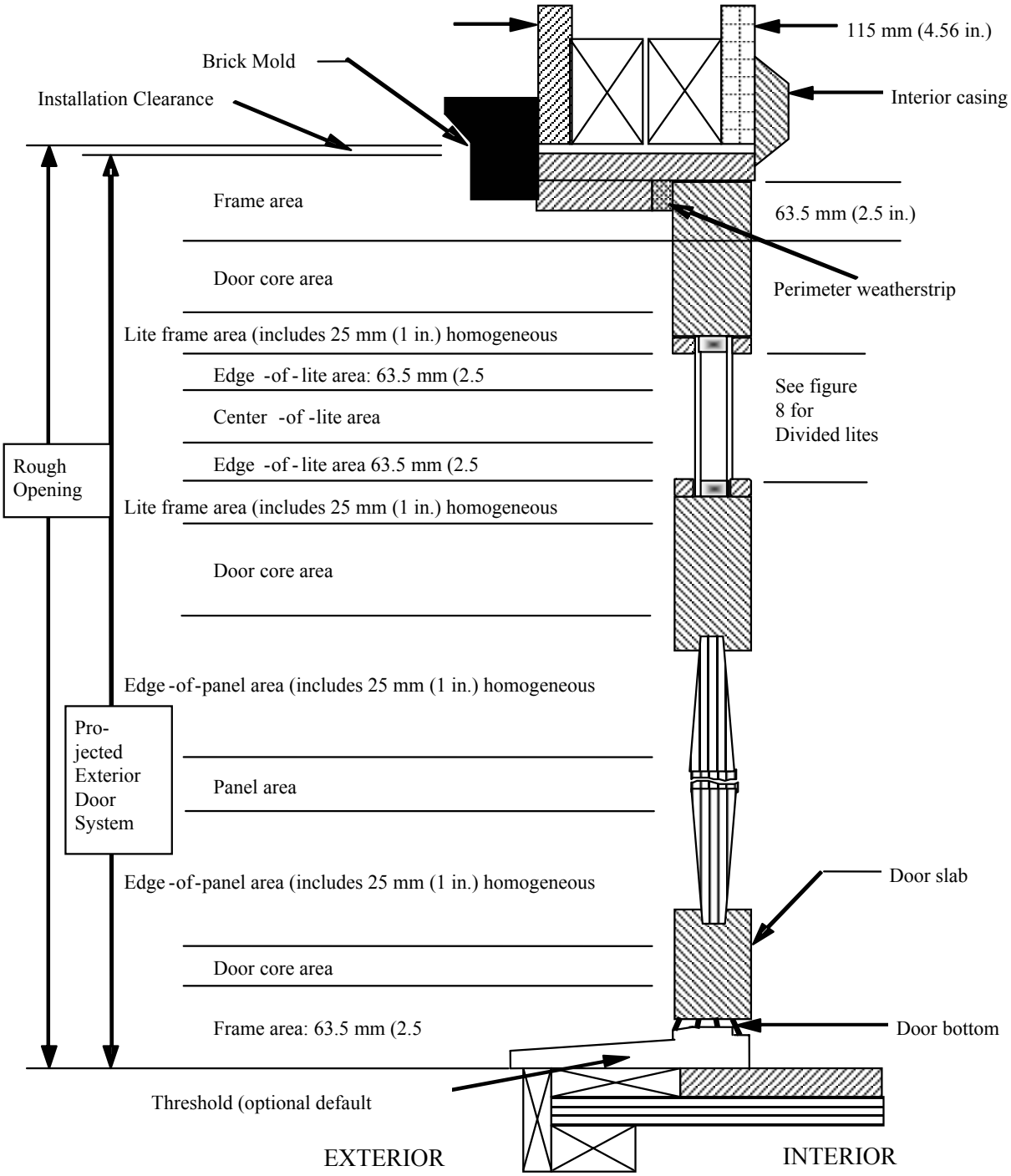
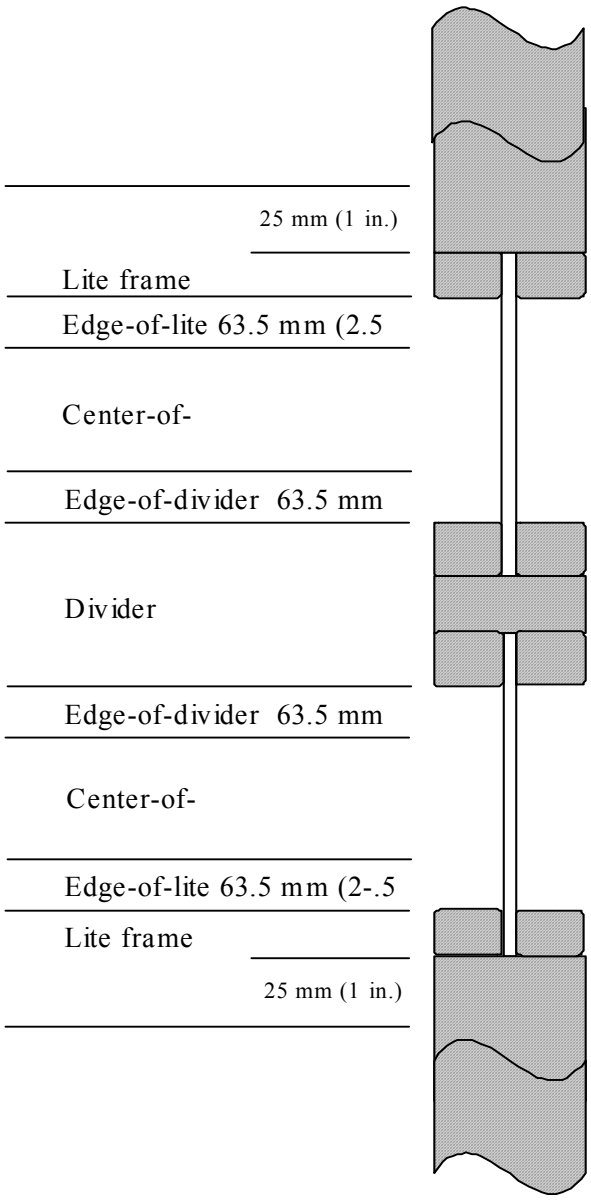


FIGURE 7: Exterior Wood Door System Area Schematic — Vertical Elevation



The projected door product area is the rough opening area less installation clearances. Side-lite area schematic may be identical or similar without perimeter weatherstrip and bottom sweep.

FIGURE 8: Door Lite with Divider Area Schematic—Vertical Elevation



Center-of-lite, edge-of-lite, divider, edge-of-divider, and frame areas for typical door lite product. Edge-of-lite and -edge-of-divider areas are 63.5 mm (2.5 in.) wide.

FIGURE 9: Typical 6-Panel Layout

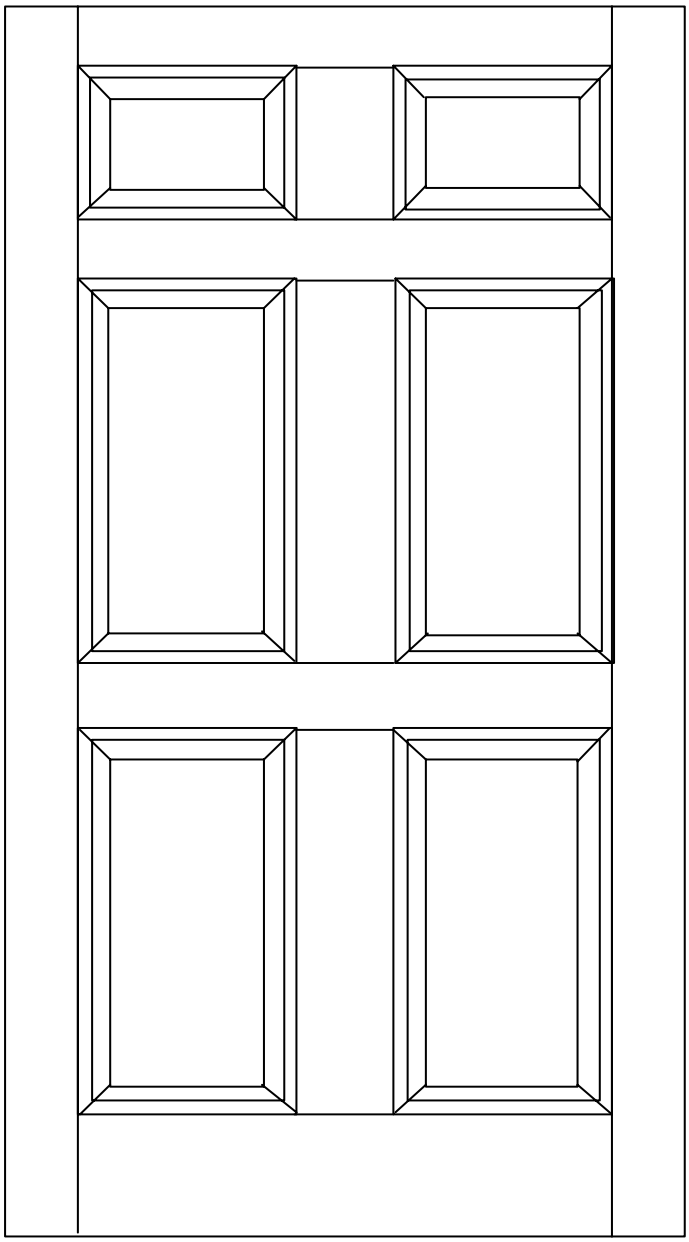
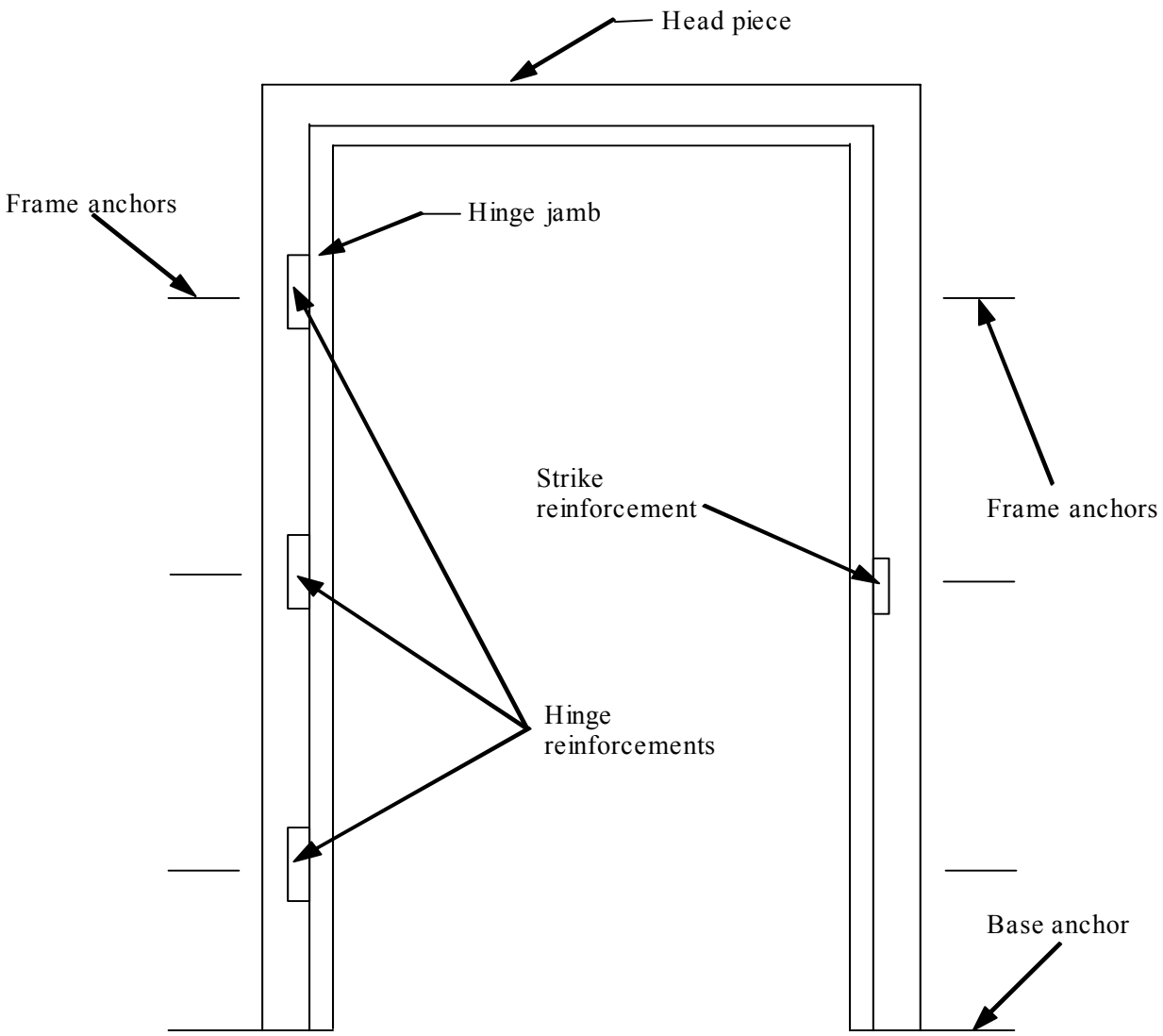
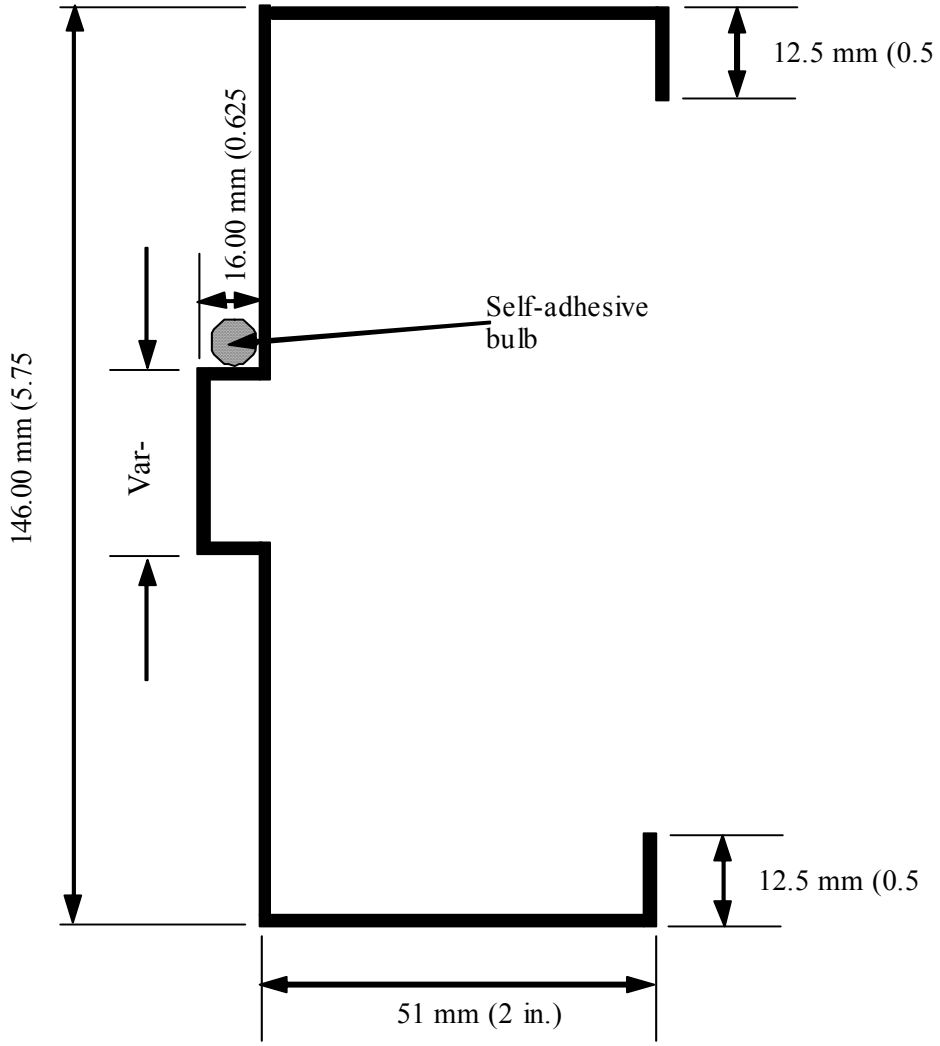


FIGURE 10-1: Common Pressed-Steel Frame



Single-Unit Type Pressed-Steel Frame

FIGURE 10-2: Frame Cross Section



PRESSED STEEL FRAME SPECIFICATIONS

1. Single-unit type pressed steel frames shall consist of a head, a sill and two jamb pieces, hinge reinforcements, a strike plate reinforcement, and base and wall anchors.
2. The wall anchors provided shall be adjustable or fixed masonry anchors, bolts with expansion shells, channel clips, “Z” clips, wood stud anchors or steel anchors.
3. The head and jamb pieces shall be constructed, as shown in Figures 10-1

FIGURE 11 (GD1): Garage Door Vertical Schematic

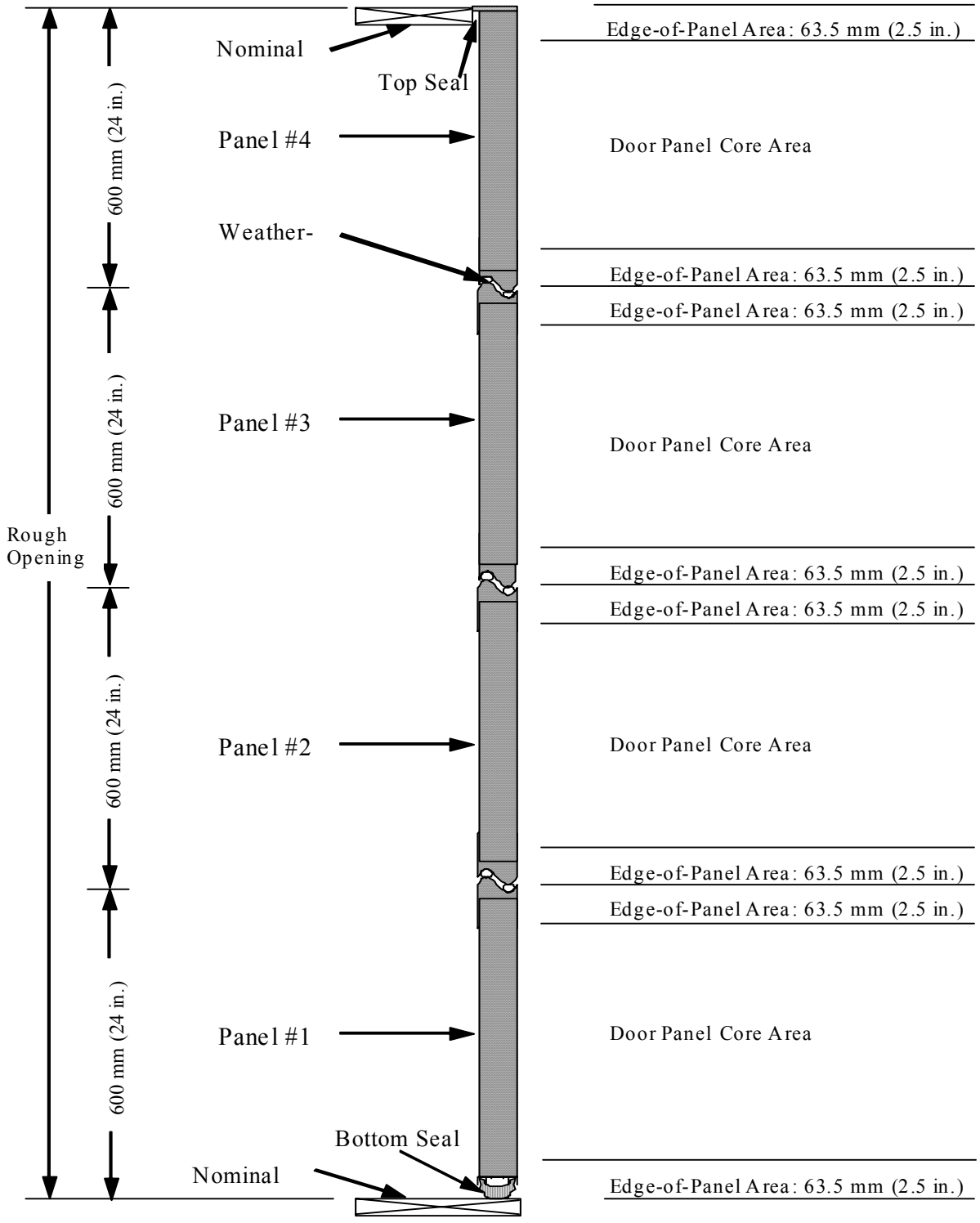
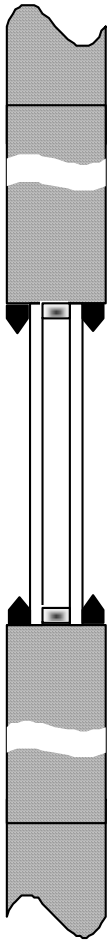


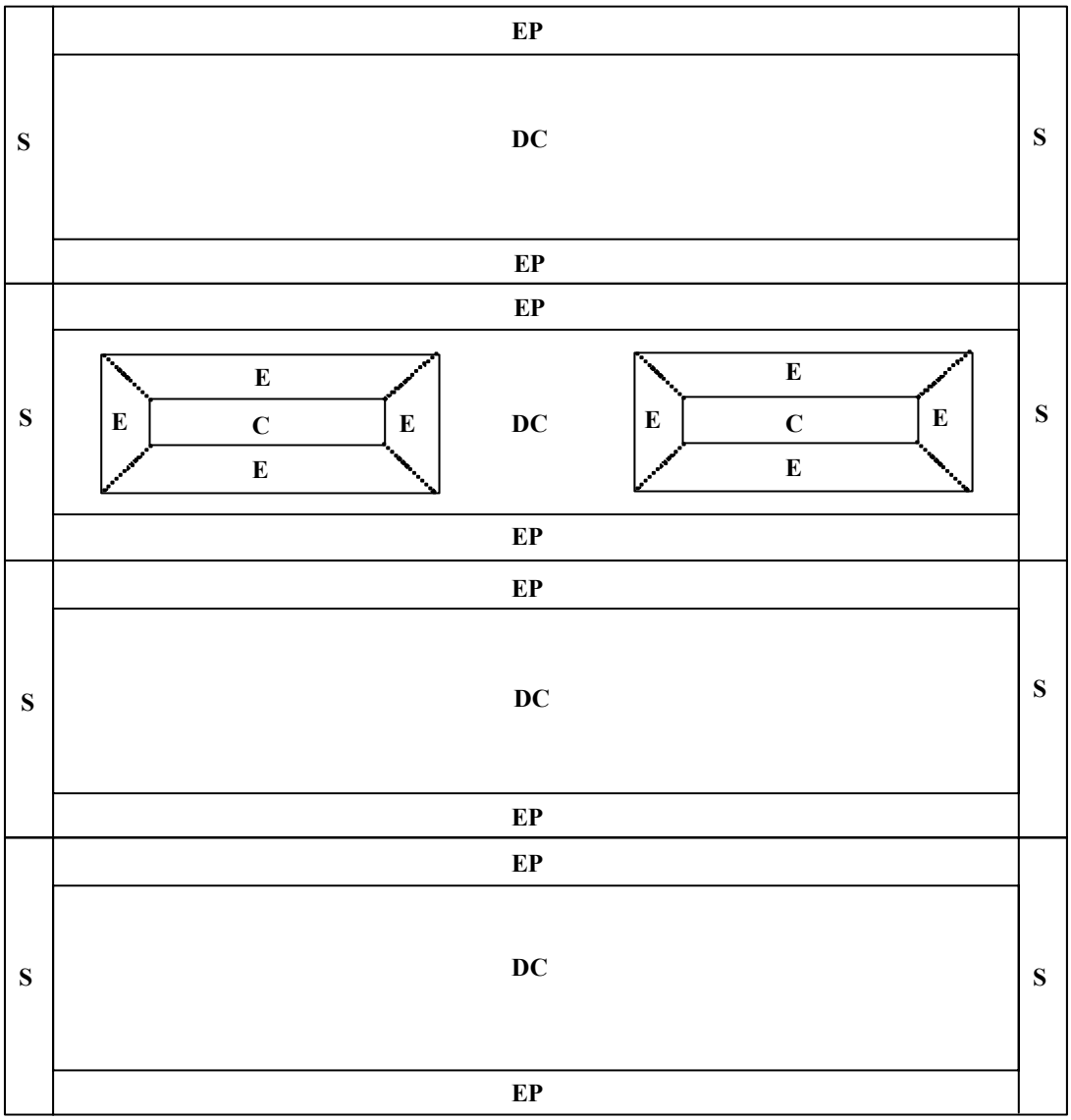
Figure 12 (GD2): Vertical Elevation, Glazing Area



Note: Only necessary if glazing is included in individual product of a product line.

Not to Scale

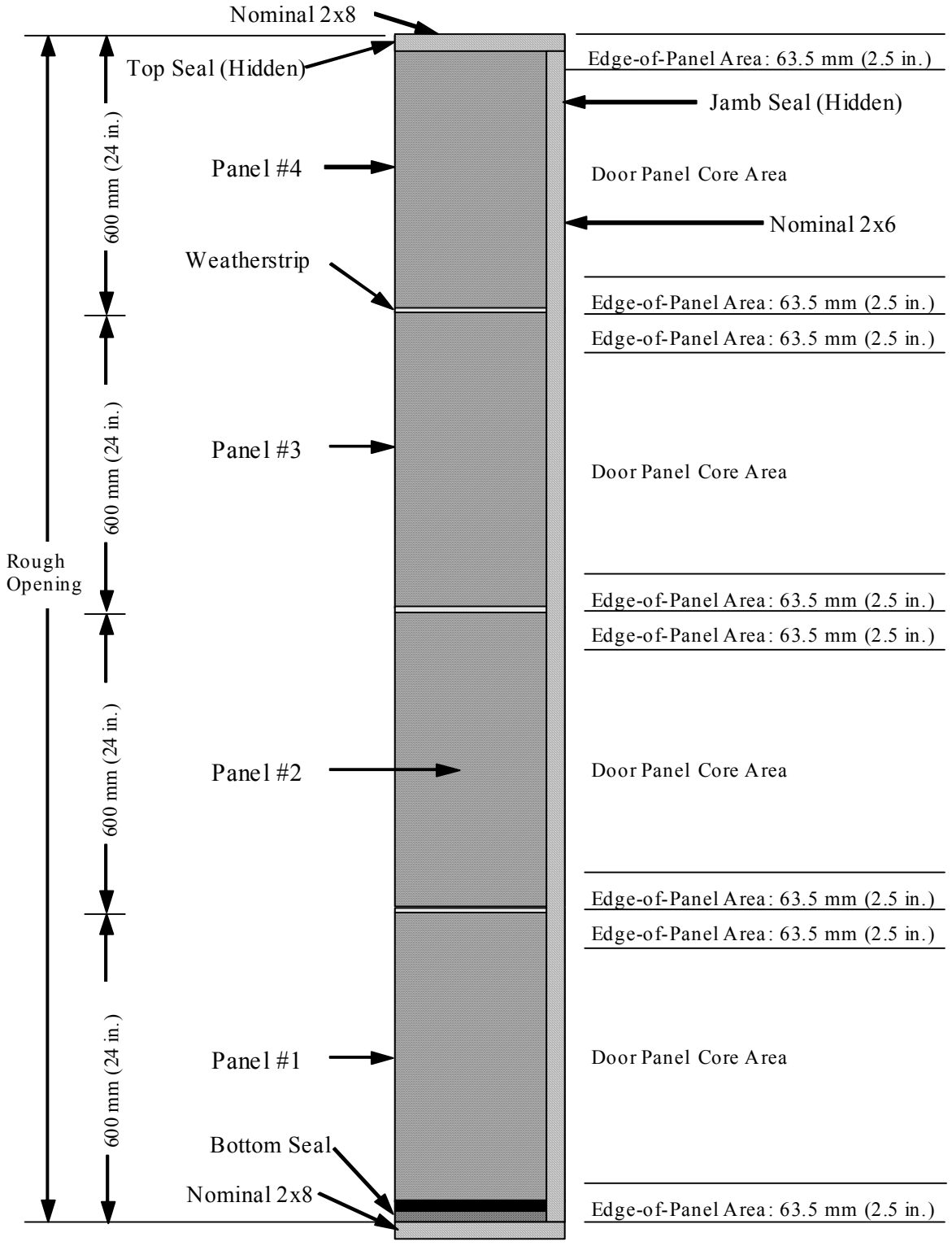
FIGURE 13 (GD3): Garage Door Product Schematic—Vertical Elevation



LEGEND
S Stile
DC Door Core
EP Edge-of-Panel
E Edge-of-Glazing (only if glazing is used; number of lites may vary)
C Center-of-Glazing (only if glazing is used; number of lites may vary)

Not to Scale

FIGURE 14 (GD4): Garage Door Horizontal Jamb Schematic (Exterior



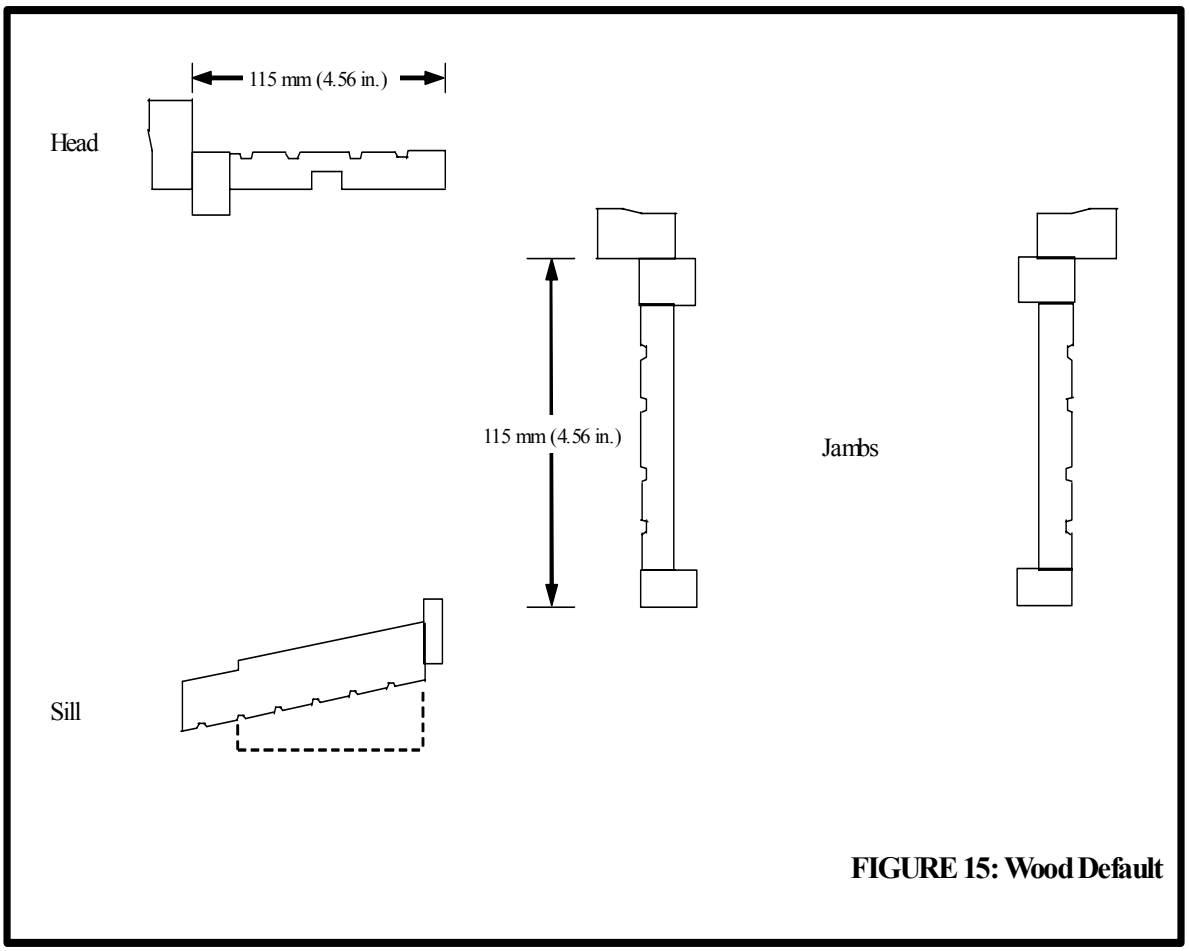
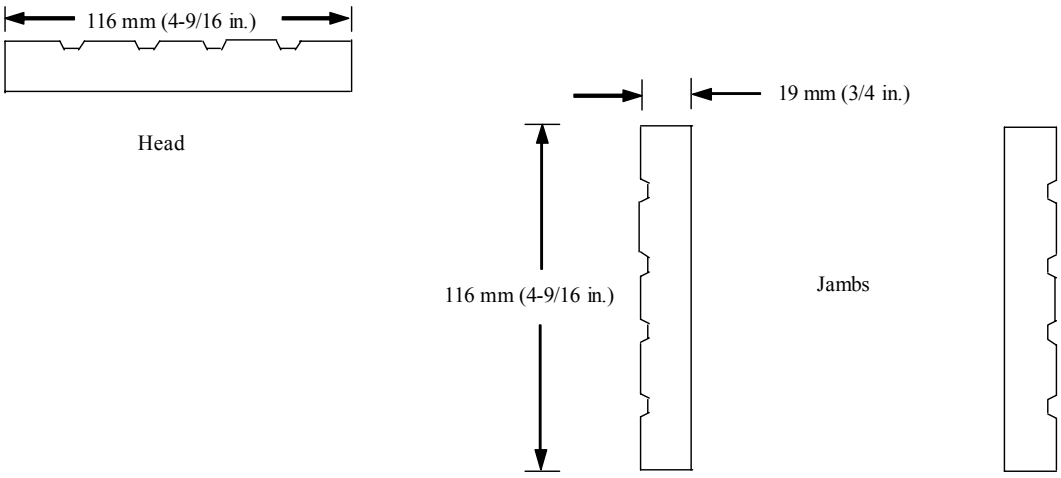


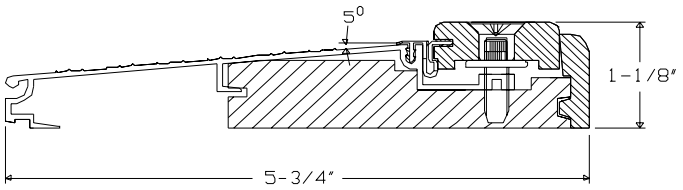
FIGURE 15: Wood Default



Note: NOT TO SCALE

FIGURE 16-1: Default Door Wood Frame

Figure 16-2: Default Door Sill



RAIL ADJUSTMENT: +3/16"/-1/16"

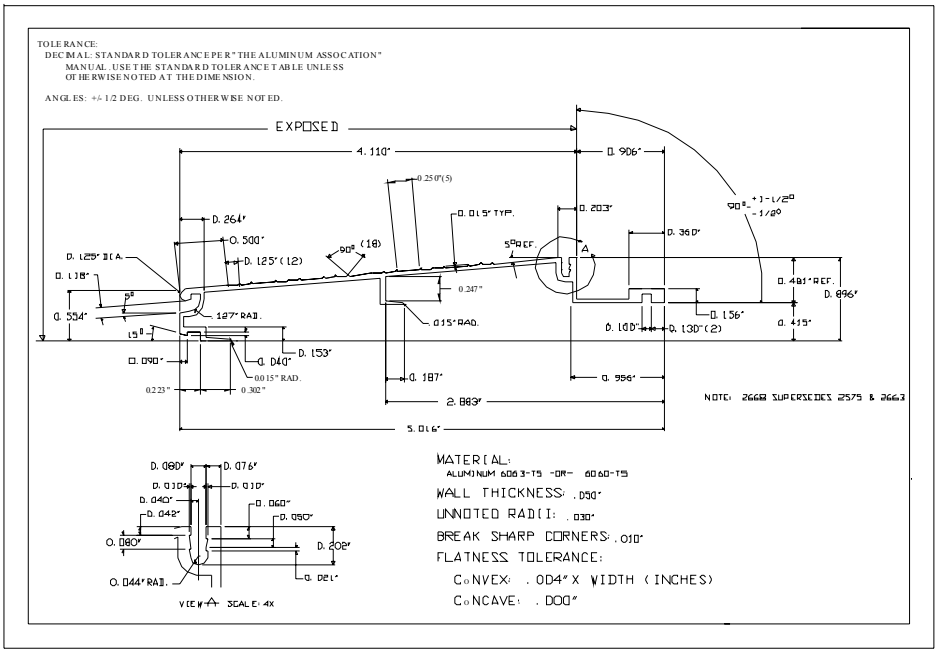
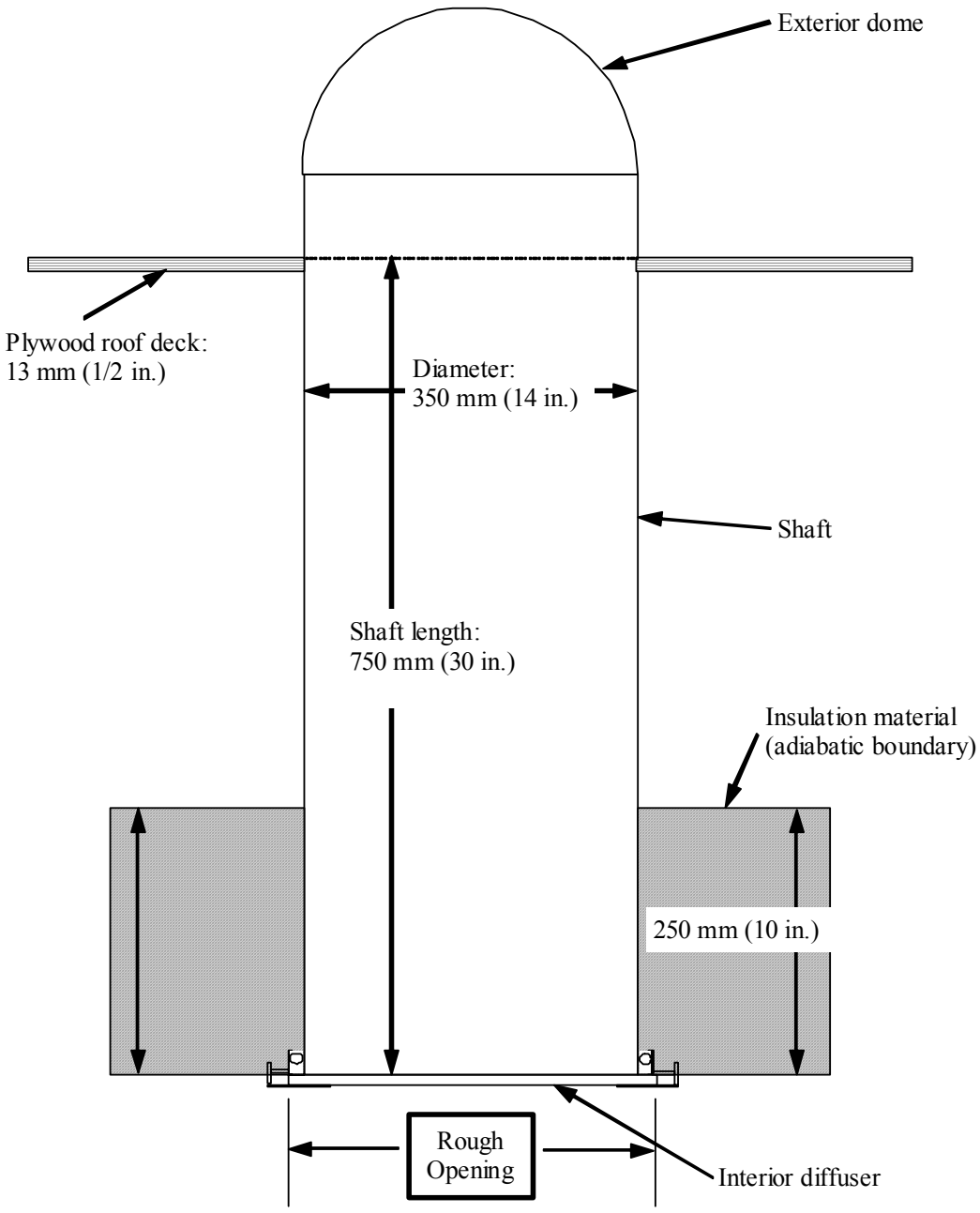
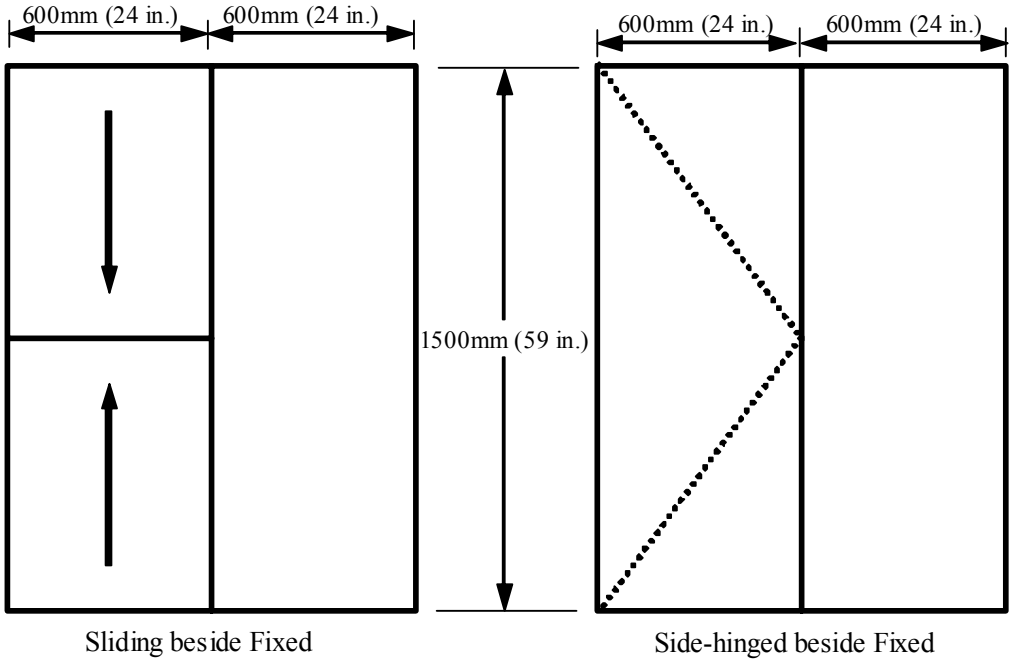


FIGURE 17: Tubular Daylighting Device Product Schematic: Vertical Elevation



Note: See Reference 13 of NFRC 100 for a more detailed drawing of the rough opening and diffuser plate attachment.

FIGURE 18: Factory Assembled Composite Window Units



Fixed beside Sliding or Side-hinged

Fixed over/under Sliding or Top/Bottom

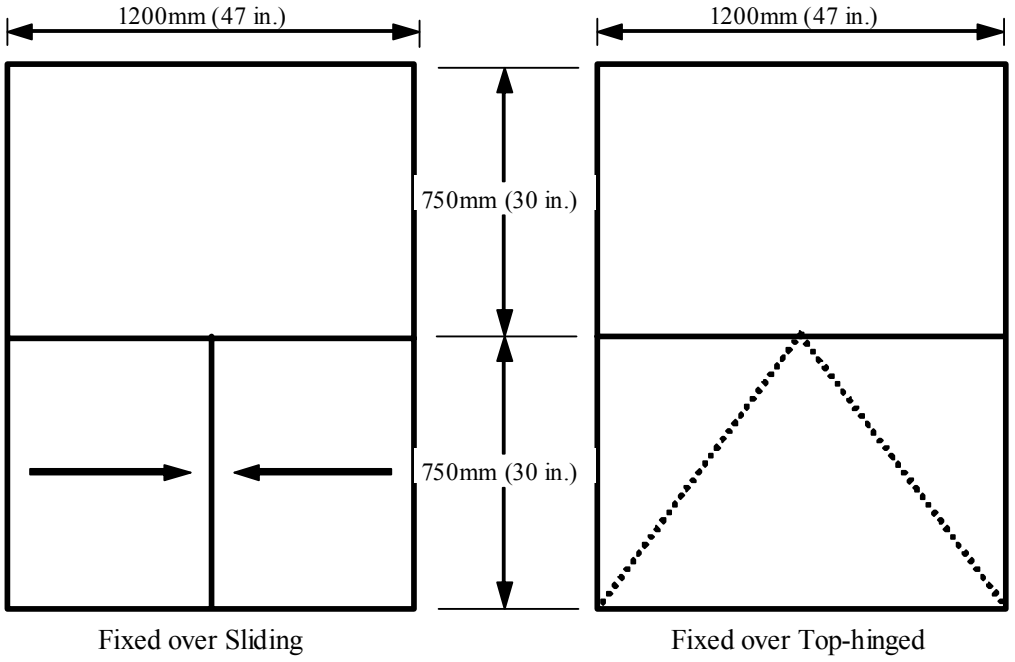


Figure 19: Sightline Examples

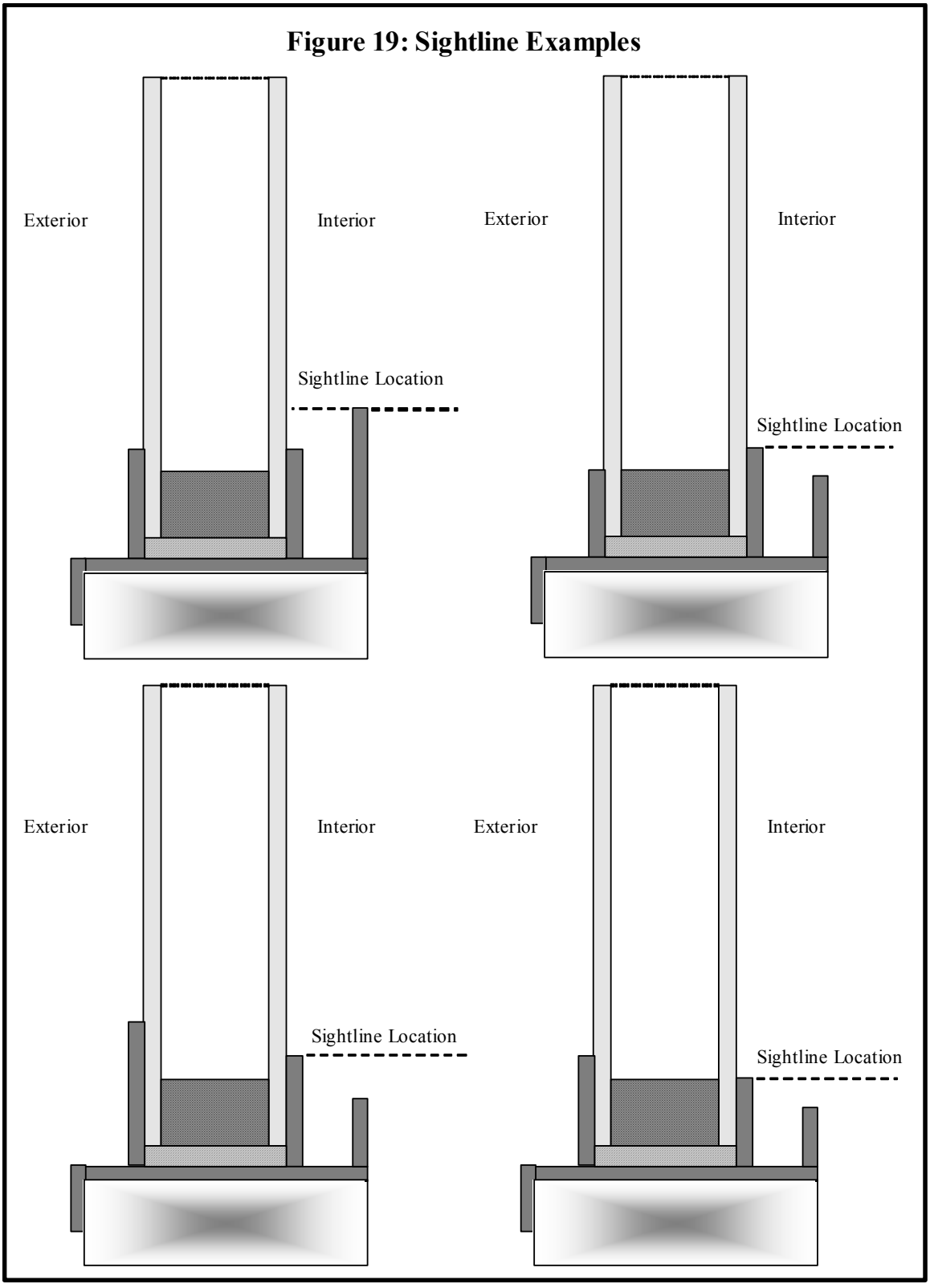
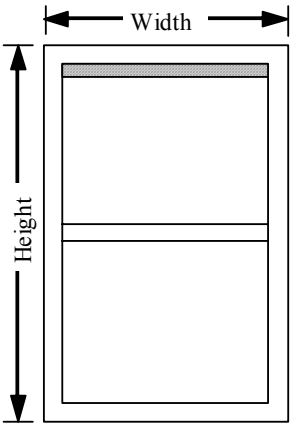


FIGURE 20 (IV1): Integral Ventilators

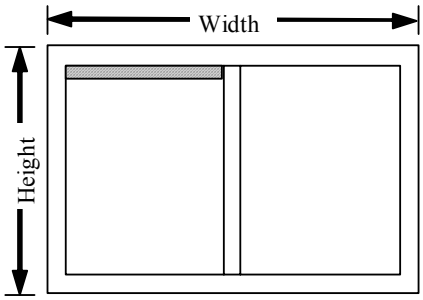
Note: The glazing area (daylight opening) Used in the calculations and sash members will vary by manufacturer.

Vertical Slider



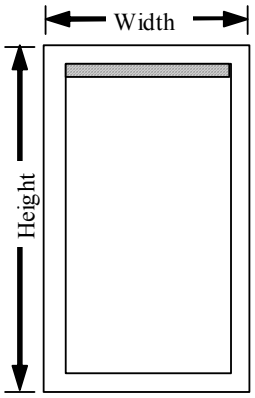
Vent Height = 45 mm (1.75 in.)
Window Area = X m^2 (X ft^2)
Area Vent = X m^2 (X ft^2)
% Area of vent

Horizontal Slider



Vent Height = 45 mm (1.75 in.)
Window Area = X m^2 (X ft^2)
Area Vent = X m^2 (X ft^2)
% Area of vent
to window = X m^2 (X ft^2)

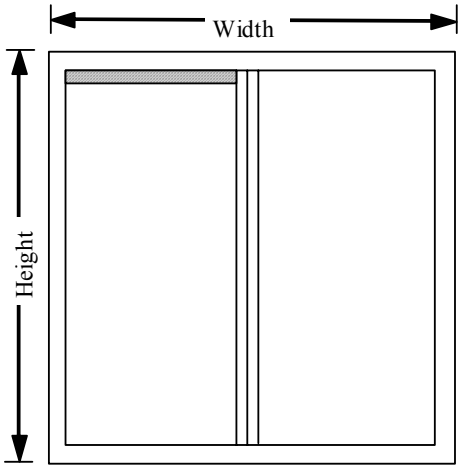
Casement/Skylights



Vent Height = 45 mm (1.75 in.)
Window Area = X m^2 (X ft^2)
Area Vent = X m^2 (X ft^2)
% Area of vent
to window = X m^2 (X ft^2)

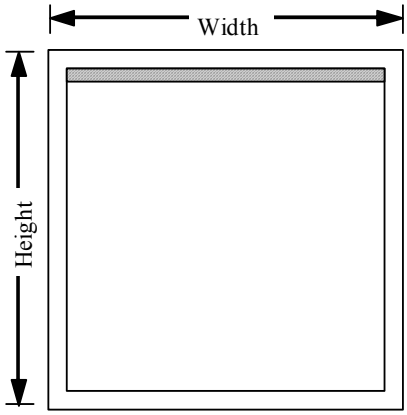
Note: For appropriate widths and heights, see Table 1.

Double and Multiple Doors w/ Frame



Vent Height = 45 mm (1.75 in.)
Window Area = X m^2 (X ft^2)
Area Vent = X m^2 (X ft^2)
% Area of vent
to window = X m^2 (X ft^2)

Fixed Windows



Vent Height = 45 mm (1.75 in.)
Window Area = X m^2 (X ft^2)
Area Vent = X m^2 (X ft^2)
% Area of vent
to window = X m^2 (X ft^2)

8.0 Appendices

APPENDIX A

A.1 Determination of U-factors at Non-Standard Sizes

A U-factor-rating matrix that is size specific may be developed in accordance with NFRC 100 procedures and requirements by an NFRC-accredited simulation laboratory, using NFRC-approved software tools. A matrix shall only be developed for those Product Lines, and Individual Products of a Product line, that have been submitted to an NFRC-Licensed Independent Certification and Inspection Agency (IA) for certification authorization purposes at the product size as defined in NFRC 100 Table 1, and issued a certification authorization. Products that have previously received certification authorization may also have a matrix developed. Each matrix shall be specific to an Individual Product within a Product Line.

The matrix shall include the standard rating size and sizes that are defined by the manufacturer.

Note: Until such time that a certification change is made in the NFRC Product Certification Program, the thermal performance parameters that are determined at sizes other than the product size in NFRC 100 Table 1 are for informational purposes only.

U-Factor Size Matrix for Series XXXX Vertical Slider

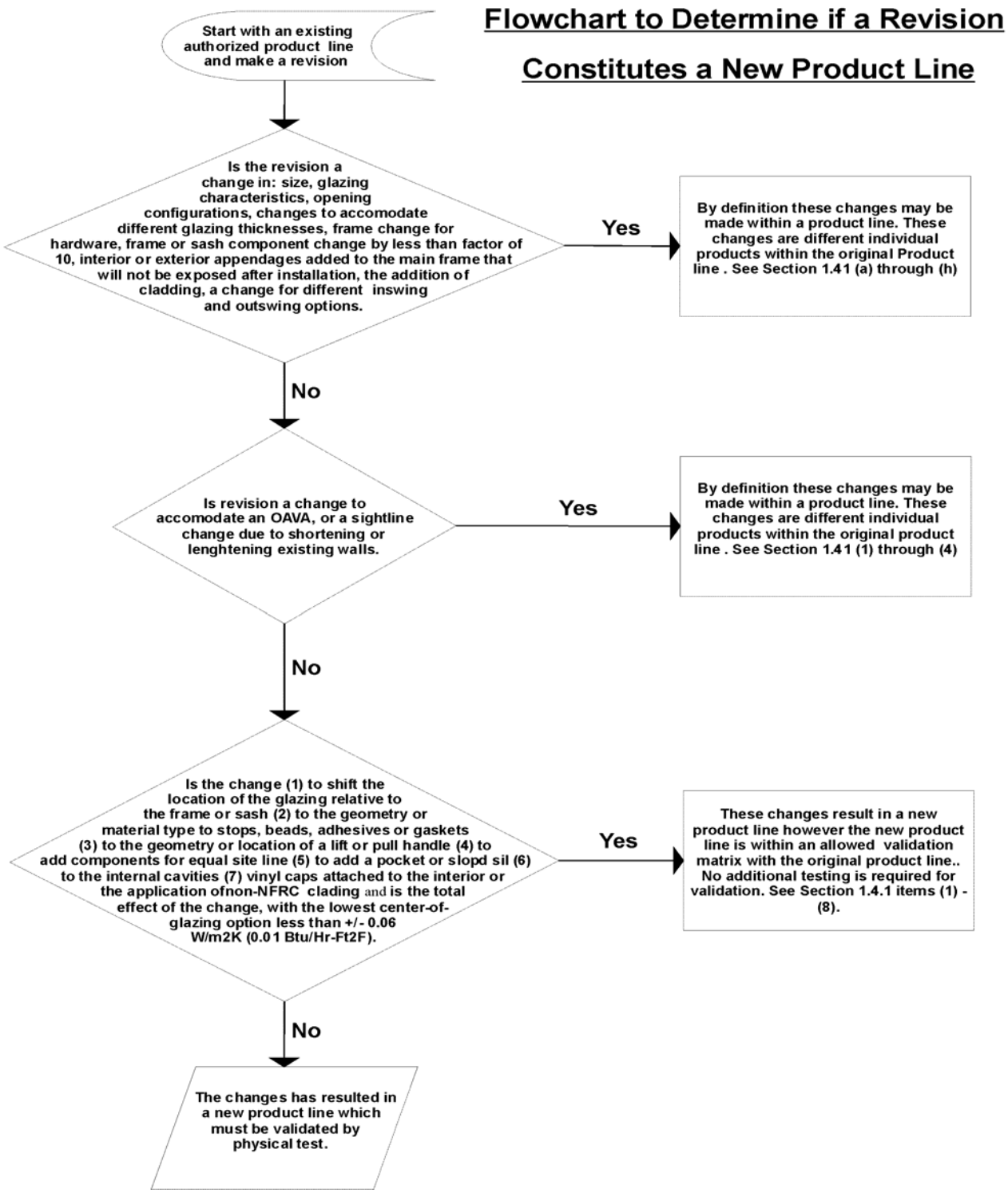
EXAMPLE ONLY - Widths, Heights and U-factors

Height \ Width	24	36	60	72	*36*	84	96	108	120
24	0.66	0.59	0.54	0.53	0.59	0.52	0.51	0.51	0.50
36	0.63	0.55	0.49	0.48	0.55	0.47	0.46	0.45	0.45
60	0.60	0.52	0.46	0.44	0.52	0.43	0.42	0.41	0.41
72	0.60	0.51	0.45	0.43	0.51	0.42	0.41	0.40	0.40
60	0.60	0.52	0.46	0.44	***0.52***	0.43	0.42	0.41	0.41
84	0.59	0.51	0.44	0.42	0.51	0.41	0.40	0.40	0.39
96	0.59	0.50	0.44	0.42	0.50	0.41	0.40	0.39	0.38
108	0.59	0.50	0.43	0.42	0.50	0.40	0.39	0.39	0.38
120	0.59	0.50	0.43	0.41	0.50	0.40	0.39	0.38	0.38

Indicates NFRC 100 Standard Size for Certification and Rating Purposes

The values stated, other than the identified standard size, in the matrix above are for informational purposes only and have not been authorized for certification. The standard size rating is also shown on the NFRC Temporary Label. For additional information, contact the IA issuing the Certification Authorization, which is identified on the NFRC Temporary Label.

APPENDIX B


Flowchart to Determine if a Revision Constitutes a New Product Line
Start with an existing authorized product line and make a revision
Is the revision a change in: size, glazing characteristics, opening configurations, changes to accomodate different glazing thicknesses, frame change for hardware, frame or sash component change by less than factor of 10, interior or exterior appendages added to the main frame that will not be exposed after installation, the addition of cladding, a change for different inswing and outswing options.
Yes
By definition these changes may be made within a product line. These changes are different individual products within the original Product line . See Section 1.41 (a) through (h)
No
Is revision a change to accomodate an OAVA, or a sightline change due to shortening or lenghtening existing walls.
Yes
By definition these changes may be made within a product line. These changes are different individual products within the original product line . See Section 1.41 (1) through (4)
No
Is the change (1) to shift the location of the glazing relative to the frame or sash (2) to the geometry or material type to stops, beads, adhesives or gaskets (3) to the geometry or location of a lift or pull handle (4) to add components for equal site line (5) to add a pocket or slopd sil (6) to the internal cavities (7) vinyl caps attached to the interior or the application ofnon-NFRC clading and is the total effect of the change, with the lowest center-of-glazing option less than +/- 0.06 W/m2K (0.01 Btu/Hr-Ft2F).
Yes
These changes result in a new product line however the new product line is within an allowed validation matrix with the original product line.. No additional testing is required for validation. See Section 1.4.1 items (1) - (8).
No
The changes has resulted in a new product line which must be validated by physical test.

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9.0 References

[1] ***National Fenestration Rating Council.*** NFRC 102: *Test Procedure for Measuring the Steady- State Thermal Transmittance of Fenestration Systems*. Silver Spring, MD.

[2] ***National Fenestration Rating Council. Therm5.1/Window5.1*** *Simulation Manual*. Silver Spring, MD.

[3] ***American Society for Testing and Materials. C177-97:*** *Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus*. Annual Book of Standards. Philadelphia, PA.

[4] ***American Society for Testing and Materials. C518-98:*** *Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus*. Annual Book of Standards. Philadelphia, PA.

[5] ***National Fenestration Rating Council****. List of Approved Simulation Programs*. Silver Spring, MD.

[6] ***American Society for Testing and Materials. C1363-97:*** *Standard Test Method for the Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus.* Annual Book of Standards. Philadelphia, PA.

[7] ***American Society for Testing and Materials. E1530-99:*** *Standard Test Method for Evaluation the Resistance to Thermal Transmission of Thin Specimens of Materials by the Guarded Heat Flow Meter Technique.* Annual Book of Standards. Philadelphia, PA.

[8] ***IEEE-ASTM-SI-10 (2001):*** *Standard for use of the International System of Units (SI): The Modern Metric System. (Replaces ASTM E380)*.

[9] ***American Society for Testing and Materials. C1036-91 (Re-approved 1997)*** *Standard Specification for Flat Glass,* Annual Book of Standards, Philadelphia, PA.

[10] ***American Society for Testing and Materials, C1114-98*** *Standard Test Method for Steady State Thermal Transmision Properties by Means of the Thin-Heater Apparatus,* Annual Book of Standards. Philadelphia, PA.

[11] ***2001 ASHRAE Handbook of Fundamentals,*** Atlanta, GA.

[12] ***ANSI/DASMA 105-98***

[13] ***Proposed Methodology for Modeling Tubular Skylights (Daylighting Devices) for NFRC Rating Purposes,*** University of Massachusetts Technical Report, June 27, 2001.

[14] **ISO/FDIS 15099 (2001) – Thermal Performance of Windows, Doors and Shading Devices - Detailed Calculations**

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10.0 Unit Conversions

The following conversions are used in this document. Values are then rounded to an appropriate number of significant figures. A complete guide to SI and its use may be found in Reference 8.

Measurement	To Convert	To	Multiply by
Length	inch (in.)	millimeter (mm)	25.4
Length	feet (ft)	millimeter (mm)	304.8
Area	square inch ($in.^2$)	square millimeter (mm^2)	645.16
Area	square feet (ft^2)	square meter (m^2)	0.09290
U-factor	$Btu/hr \cdot ft^2 \cdot F$	$W/m^2 \cdot K$	5.678
R-value	$hr \cdot ft^2 \cdot F/Btu$	$m^2 \cdot K/W$	0.1761
Conductivity	$Btu \cdot in./hr \cdot ft^2 \cdot F$	$W/m \cdot K$	0.1442
Conductivity	$Btu/hr \cdot ft \cdot F$	$W/m \cdot K$	1.73

*[**Note**: In this document, the Inch-Pound (IP) unit values were converted to Metric (SI) units. The metric values were then rounded off to the significant digits. Therefore, the user of this document may find slight disagreement in values when converting from SI to IP units. In this event, IP unit values shall be used as it appears in the parentheses.]*

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PART II

11.0 Site-Built - NFRC 100-SB: Procedure for Determining Site-Built Fenestration U-factors and Thermal Performance Characteristics

11.1 Purpose

To specify appropriate methods for determining the thermal transmittance (U-factor) and thermal performance characteristic of site-built fenestration systems.

Note: Reference Part 1 for additional terminology and procedures for determining thermal performance properties..

The ratings derived from this procedure may be used to compare thermal performance characteristics of site-built fenestration products and/or to provide architects, code specifiers, builders, etc. with a uniform and accurate means of determining and evaluating thermal performance characteristics of a specifically designed site-built fenestration product.

11.2 Scope

11.2.1 Site-built fenestration systems covered by this method include products that are designed to be field glazed, or field assembled units comprised of specified framing and glazing components, including but not limited to:

11.2.1.1 Transparent and translucent wall systems where the glazing material is glass, plastic or other light transmitting panels (including opaque spandrel panels within the system), except those products where no testing or calculation procedure exists;

11.2.1.2 Glazed wall support and framing systems;

11.2.1.3 Products of any size and design;

11.2.1.4 Products with single or multiple glazing layers;

11.2.1.5 Products with spacer systems between glazings;

11.2.1.6 Horizontal, vertical and sloped systems;

11.2.1.7 Products that, by design, may have multiple framing components and/or glazing combinations.

11.2.1.8. Fenestration Systems using Unitized Construction, where a system is field assembled from factory assembled sub-units.

11.2.2 Systems not covered include totally opaque walls and pre-assembled or pre-glazed fenestration products (See Table 1of Part 1).

11.3 Terminology

Curtain wall: Any building wall, of any material, which carries no superimposed vertical load (a non-bearing wall).

Curtain wall system: That portion of the exterior wall which may consist entirely (or principally) of a combination of framing materials, glass and glazing, opaque in-fill and other surfacing materials supported by (or within) a framework, in varying percentages per the design of the system.

Window wall: A type of curtain wall installed between floors (or between floor and roof) that is typically composed of vertical and horizontal framing members containing operable or ventilators, fixed lights or opaque panels, or any combination thereof in varying percentages per the design of the system.

Sunroom/Solarium: A glazed envelope system that has one wall, or a portion thereof, which opens to a primary structure and remaining walls which may include a number of fenestration systems such as windows, doors, skylights, kneewalls, etc, in varying percentages per the design of the system.

Structurally glazed framing: A method of glazing where framing members are generally not exposed to the exterior. (i.e. 2-sided or 4-sided structural glazed)

Non-thermally broken members: System members with less than 1.6 mm (1/16 in.) or no separation between metal or system members.

Outdoor Air Ventilator System (OAVA): An assembly that allows for the exchange of air through the envelope that is an integral part of the fenestration assembly. If the OAVA area does not exceed 1.25% of the area of the glazed wall system it is considered to have the same U-factor as the glazed wall system. If the OAVA area exceeds this percentage, a separate U-factor must be determined for the OAVA and glazed wall system.

Opaque in-fill systems: Curtain wall systems that include opaque and/or glazing systems supported by a frame network.

Site-Built Products: Fenestration products that are designed to be field glazed or field assembled units comprised of specified framing and glazing components including: operable and fixed windows; curtain walls, window walls, storefronts, sloped glazing and skylights.

11.4. Determining Thermal Transmittance (U-factor) for Vertical Glazed Wall Systems (Site-built), including Curtain Wall and Window Wall Components

11.4.1 The thermal transmittance of Curtain Walls and Window Walls shall be determined in accordance with Part 1, Section 2.2 (Approved Total Fenestration Product U-factor Calculational Procedure) of this standard. The U-factor for the fenestration product components (framing system and glazing system) shall be determined as follows:

11.4.2 Each Product Line shall have one baseline product be validated in accordance with Part 1, Section1 and 2, with the following exception:

11.4.2.1. Unspecified Product Sample Validation Criteria: If the product to be used for validation purposes is not specified, then the individual product used for validation purposes shall be simulated and tested using the following criteria: The test specimen shall be constructed in such a manner as to be identical to the individual product simulated and have outside dimensions measuring 2000 mm by 2000 mm (a nominal 79 in. width and an 79 in. height), having one vertical mullion and two glazed lites. The glazing system configuration for the validation testing shall be nominal 25 mm (1 in.) outside dimension insulating glass utilizing two lites of 6 mm (1/4 in.) clear (uncoated glass), a typical dual-sealed aluminum spacer system and air-filled. There shall be no insulation of any type applied to the test specimen during validation testing. Validation will be achieved per Part 1, Section 1.6.1.1 .

11.4.2.2 This section is to be used only in those instances where the representative sample for validation purposes has not been prescribed by a specifying authority such as an architect, project manager, engineering firm, building owner, etc.

11.4.2.3 For simulating and testing all other fenestration operator types other than glazed wall systems, sloped glazing and solarium/sunroom systems, model sizes shall be consistent with the sizes listed in Table 1, Part 1 of this standard..

11.5. Determining thermal transmittance (U-factor) for sloped glazing systems

11.5.1 All sloped glazing systems shall be rated for thermal performance characteristics as noted in Section 11.4 and shall be rated at a slope of 20 degrees above the horizontal (See Part 1, Section 4 Skylights for more information).

11.6. Determining the thermal transmittance for solarium/sunroom systems

Note: This procedure is to be used when the solarium is glazed on-site. If manufactured window or door systems are used to create the glazed walls in a solarium, the thermal transmittance shall be determined in accordance with Part 1 of this standard.

11.6.1 The thermal transmittance of solarium/sunroom systems shall be determined in accordance with Part 1, Section 2. (Approved Total Fenestration Product U-factor Calculation Procedure) of this standard.

11.6.2 For simulating and testing site-built vertical glazed wall sections of solarium/sunroom systems, each Product Line shall have one baseline product be validated in accordance with Part 1, Section1 and 2, with

the following exception: The individual product used for validation purposes shall be simulated and tested using the following criteria: The test specimen shall be constructed in such a manner as to be identical to the individual product simulated and have outside dimensions measuring 2000 mm by 2000 mm (a nominal 79 in. width and an 79 in. height), having one vertical mullion and two glazed lites. The glazing system configuration for the validation testing shall be nominal 25 mm (1 in.) outside dimension insulating glass utilizing two lites of 3 mm (1/8 in.) clear (uncoated glass), a typical dual-sealed aluminum spacer system and air-filled. There shall be no insulation of any type applied to the test specimen during validation testing. Validation will be achieved per Part 1, Section 1.6.1.1.

11.6.3 Sloped glazing systems shall be rated in accordance with Section 11.5 utilizing sample construction as described in paragraph 11.6.2.

11.6.4 For simulating and testing all other fenestration operator types other than glazed wall systems and sloped glazing systems, model sizes shall be consistent with the sizes listed in Table 1, Part 1 of this standard, with glazing in accordance with Section 11.6.2.1.

11.7. Determination of System Solar Heat Gain Coefficients and, Visible Light Transmittance Ratings

11.7.1. The system Solar Heat Gain Coefficient (SHGC) and Visible Light Transmittance (VT) ratings shall be determined, by an NFRC-accredited simulation laboratory, using a mathematical model which utilizes components of the total system design. The total system ratings shall be calculated using the procedures outlined in NFRC 200.

11.7.2 Specialty products SHGC and VT – Site-Built fenestration systems shall meet the requirements of Section 7.1 when utilizing the specialty products methodology as noted below:

11.7.2.1 Pre-Calculated Solar Heat Gain Coefficient And Visible Transmittance Tables. A table, or spreadsheet matrix, is created by an NFRC-accredited simulation laboratory utilizing the thermal performance rating of particular product line and determining product SHGC ratings with two fictitious glazings: one product has a glazing with an SHGC of 0 and one with a glazing with an SHGC of 1.

11.7.2.2. If the product line includes dividers, the laboratory shall include the SHGC0 and SHGC1 values for cases with no dividers; cases with dividers less than or equal to 25.4 mm (1.0in.); and cases with dividers greater than 25.4 mm (1.0 in.).

11.7.2.3 Once the SHGC0 and SHGC1 ratings for the product line have been determined; the pre-calculated total fenestration product SHGC can be determined from the center-of-

glazing (COG) SHGC by the following equation:

Total Product SHGC = SHGC0 + $SHGC_{cog}$ x (SHGC1 – SHGC0)

11.7.2.4 Total fenestration product VT is determined in a similar manner, as follows:

11.7.2.4.1 A table is created by an accredited simulation laboratory utilizing the thermal performance rating of particular product line and determining product VT ratings with two fictitious glazings: one product has a glazing with a VT of 0 and one with a glazing with a VT of 1.

11.7.2.4.2 If the product line includes dividers, the laboratory shall include the VT0 and VT1 values for cases with no dividers; cases with dividers less than or equal to 25.4 mm (1.0 in.); and cases with dividers greater than 25.4 mm (1.0in.).

11.7.2.4.3 Once the VT0 and VT1 ratings for the product line have been determined; the pre-calculated total fenestration product VT can be determined from the center-of-glazing (COG) VT by the following equation:

Total Product VT =VT0 + VT_{cog} x (VT1 – VT0)

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APPENDIX A
(Non-mandatory Information)

A.1 Determination of Project Specific U-Factors

The system U-factor ratings for project specific U-factors shall be determined by an NFRC-accredited simulation laboratory, using NFRC-approved software tools which utilizes components of the NFRC-certified system, specifically with the frame, edge-of-glazing and center-of-glazing U-factors. Each component of the total system shall be assigned percentages of the total product, and the total system U-factor shall be calculated using the procedures outlined in NFRC 100, Section 2.2 5.4.3.

Note: Reference the contents of Section 11.4 4.0 of this document.

APPENDIX A
(Non-mandatory Information)

A.2 Determination of U-factors at Non-Standard Sizes

A U-factor-rating matrix that is size specific may be developed in accordance with NFRC 100 procedures and requirements. A matrix shall only be developed for those Product Lines, and Individual Products of a Product line, that have been submitted to an NFRC-Licensed Independent Certification and Inspection Agency (IA) for certification authorization purposes at the product size as defined in NFRC 100 Table 1. Products that have previously received certification authorization may also have a matrix developed. Each matrix shall be specific to an Individual Product within a Product Line.

The matrix shall include the standard rating size and sizes that are defined by the manufacturer.

The fenestration thermal performance parameter ratings (i.e.: U-Factor,) shall be determined by an NFRC-accredited simulation laboratory, using NFRC-approved software tools, which utilizes components of the NFRC-certified system, specifically with the frame, edge-of-glazing and center-of-glazing thermal performance ratings, where applicable. Each component of the total system shall be assigned percentages of the total product, and the total system thermal performance parameter shall be calculated using the procedures outlined in NFRC 100, Section 2.2.

Note: Until such time that a certification change is made in the NFRC Product Certification Program, the thermal performance parameters that are determined at sizes other than the product size in NFRC 100 Table 1 are for informational purposes only.

U-Factor Size Matrix for Series XXXX Curtain Wall

EXAMPLE ONLY - Widths, Heights and U-factors

Height \ Width	**36**	**48**	**60**	**72**	***80***	**84**	**96**	**108**	**120**
36	0.55	0.52	0.49	0.48	0.47	0.47	0.46	0.45	0.45
48	0.53	0.49	0.47	0.46	0.45	0.44	0.44	0.43	0.42
60	0.52	0.48	0.46	0.44	0.43	0.43	0.42	0.41	0.41
72	0.51	0.47	0.45	0.43	0.42	0.42	0.41	0.40	0.40
80	0.51	0.47	0.44	0.43	***0.42***	0.41	0.41	0.40	0.39
84	0.51	0.47	0.44	0.42	0.42	0.41	0.40	0.40	0.39
96	0.50	0.46	0.44	0.42	0.41	0.41	0.40	0.39	0.38
108	0.50	0.46	0.43	0.42	0.41	0.40	0.39	0.39	0.38
120	0.50	0.46	0.43	0.41	0.40	0.40	0.39	0.38	0.38

Indicates NFRC 100 Standard Size for Certification and Rating Purposes

The values stated, other than the identified standard size, in the matrix above are for informational purposes only and have not been authorized for certification. The standard size rating is also shown on the Label Certificate, to which this matrix is attached. For additional information, contact the IA stated on the Label Certificate.

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